Unit Construction Costs

FROM THE

New Smelter

OF THE

Arizona Copper Co., Ltd.

BY

E. HORTON JONES

First Edition

REPUBLISHED BY THE
McGRAW-HILL BOOK COMPANY, Inc.
239 WEST 39TH STREET, NEW YORK
6 BOUVERIE STREET, LONDON, E. C.

By Special Arrangement with the
American Institute of Mining Engineers

1914

Unit Construction Costs From the New Smelter

OF THE

Arizona Copper Co., Ltd.

CONTENTS

Introduction

We have endeavored in the following "sheets" to give the unit construction costs derived from the building of the Arizona Copper Co.'s new smelter, Clifton, Ariz., starting in February, 1912, and completing February, 1914.[1] In Chapter I—Unit Costs—are to be found the most elementary total unit costs which the accounts provide for. They are usable in the Clifton district. Here too are found the percentages to be added to an estimate for Engineering and General Expense. In Chapter II—Comparative Costs—these elementary costs have been classified, averaged and reported as labor and material unit costs. In such form the labor unit costs, when properly applied to similar conditions as these under which they were derived, are usable anywhere. The material unit costs are better disregarded for more accurate estimates and replaced by a newly priced bill of material. In Chapter III Composite Costs are given. They are unit costs built up from several elementary units, and likewise units of larger dimensions and simpler application, valuable for

[1] The smelter went into service producing copper October, 1913.

checking estimates and obtaining quick approximations of total costs. In Chapters IV, V, and VI are given the Wage Scale, Material Prices, and a description of the conditions surrounding the making of every elementary unit cost, which will enable an estimator to judge of their use under any circumstance. It should be borne in mind that Chapter VI is not a pure description of the plant, nor of any of its parts, such as might be expected in a technical journal, but it is barely enough information for a reader to judge as to the applicability of a unit cost in another place.

These unit costs, as any examination will prove, are not ideal, but actual. They were made by a copper company organization extending over a period of two years. They represent delays in material shipments (serious delays in steel and brick deliveries), delayed plans, changes in plans, labor troubles, with changes in hours and rates, variable weather conditions, and the like. They do represent, however, every cent spent.

Each unit cost has been judged, as it stands, solely on its merits for use by an estimator. Where a unit cost is not given it was of no use, and where given and described, it must be employed accordingly.

During the first few months of construction work only the prime account numbers showing in the sheet were in use. Later, to obtain more accurate figures to measure the work by as it progressed, the decimal account numbers were added. But the decimal accounts were on record only in the engineering costing department at the new smelter, two miles from Clifton. The General Office, at Clifton, neglected all decimal accounts and charged them under the prime numbers. The labor segregation was in all instances made at the new smelter, and every charge for material, from whatever source, passed through the warehouse at the new smelter. The only other source of cost sheet entries was the General Office cash books. Once a month these entries were itemized and sent out in the monthly Cost Sheet issued by the General Office.

CHAPTER I

UNIT COSTS

The costs thus accrued from three sources. The individual labor card was not used until the excavating was well under way and the foundation work had started. Each man, who could, made out his card and told thereon exactly at what and how long he had been working. The labor bosses made out the cards for the Mexicans. The account number was later placed on the card by the time keeper and checked by a competent man in the engineering office. For every bit of material used on the job a requisition was passed through the warehouse, whether steel building or keg of nails. To this a charge number was attached and the requisition was finally checked by a competent man in the Engineering Department.

In regard to cash-book entries, there was little to be done, as all local bills were OK'd and account numbers attached by the Engineering Department in the first instance. The units were compiled by the Engineering Department daily as the work progressed and checked suitably.

Yet owing to the fact that the General Office kept the accounts segregated only under the prime account numbers, the slow development of the idea of making a final accurate unit cost sheet, the delay in using individual time cards and many clerical mistakes, it was finally thought best to check over every labor card and warehouse requisition from the beginning of the job. This was done and the unit costs as they now stand are believed to be accurate.

The making of this cost sheet is largely due to the untiring interest and insistent demand for accuracy upon the part of three members of the smelter construction force, G. H. Ruggles, M. Am. Soc. M. E.; Roy Earling, M. Am. Soc. M. E.; and H. F. Adams. Credit is due also to the ever willing assistance given by the Arizona Copper Co.'s general office, under the direction of J. G. Cooper, Cashier.

General Expense

NUMBER	NAME OF ACCOUNT	TOTAL	
7001	General expense at Clifton	See page 1581	
7004	Personal injuries	" " "	
	Engineering		
	Engineering and Superintendence at Douglas		
7101	Salaries	$39,706.22	
7103	Telegraphing and telephoning	167.55	
7104	Traveling expense	1,984.85	
7105	Miscellaneous expense	1,018.06	
			$42,876.68
	Engineering and Superintendence at Clifton		
7201	Salaries	$40,587.54	
7202	Furniture and fixtures	149.43	
7203	Telegraphing and telephoning	258.64	
7204	Traveling expense	934.24	
7205	Miscellaneous supplies	2,205.77	
7206	Miscellaneous labor	869.02	
			$45,004.64
9000.1	Power plant engineering	$12,768.56	$12,768.56
7100	Total engineering expense		$100,649.88
	Total unit cost		5.40 per cent.

This percentage is obtained by dividing the engineering expense by the total cost of the smelter, minus engineering and indirect expense.

$$\frac{100,649.88}{1,864,092.47} = 5.40 \text{ per cent.}$$

7300.—Yard Tracks and Industrial System

Tracks

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
7301	Excavation.....	$31,311.14	$4,254.86	$35,566.00	55,405 cu. yd.	$0.64
7302	Ties.....	425.13	10,777.79	11,202.92	10,262 ties	1.09
7303	Rails and rail fastenings	392.00	9,839.79	10,231.79	14,813 ft.	0.69
7304	Frogs and switches.....	206.50	2,676.95	2,883.45	18 switches	160.19
7305	Laying, surfacing and ballasting.....	5,873.53	248.88	6,122.41	17,150 ft.	0.36

Trolley System

7306	Poles and setting.....	1,427.27	1,804.73	3,232.00	106 poles	30.49
.1	Brackets and wiring.....	1,167.19	1,379.73	2,546.92	7,824 ft.	0.33
.2	Rail bonds.....	304.31	347.13	651.44	521 bonds	1.25
.3	Lighting.....	229.66	222.39	452.05	57 lamps	7.93

Rolling Stock

7307	Cars, elec. locomotives, etc.....	801.29	34,017.63	34,818.92	.....	.....
.1	Calcine car alteration...	381.02	4.36	385.38	.....	.....

Trestle Approach to Reverberatory Building

7308	Excavation.....	359.95	.....	359.95	277 cu. yd.	1.30
7308.1	Foundations.....	738.18	1,152.52	1,890.60	254.9 cu. yd.	7.42
.2	Steel structure.....	.....	.....	13,460.84	163.97 tons	82.09
.3	Woodwork.....	703.93	768.92	1,472.85	27.65 m.b.m.	53.27

150-Ton Track Scales in Receiving Yard

7309	Excavation.....	348.91	.....	348.91	388 cu. yd.	0.90
.1	Foundation.....	545.62	1,146.87	1,692.49	186 "	9.10
.11	Cost and erection.....	365.95	3,450.86	3,816.81	150 tons	25.45
.30	Scale house.....	65.66	63.87	129.53	879 cu. ft.	0.15

Bridges, Culverts and Walls

7310	Bridge No. 1 foundation.	1,028.26	1,968.38	2,996.64	339.8 cu. yd.	8.82
.1	" steel work..	.....	.....	377.40	3.70 tons	102.00
7311	Culvert No. 1 masonry..	1,384.85	695.80	2,080.65	354 lin. ft.	5.88
7312	Retaining walls excavation	77.66	.....	77.66	60 cu. yd.	1.29
.1	" " concrete.	512.34	734.25	1,246.59	203.5 "	6.13
.2	" " masonry	88.08	47.51	135.59	21.9 "	6.19

40-Ton Track Scales on Calcine Track

7313	Excavation.....	108.44	0.51	108.95	118 cu. yd.	0.92
.1	Foundation.....	207.55	193.60	401.15	41.6 "	9.64
.2	Cost and erection.....	82.99	710.85	793.84	40 tons	19.85
.3	Scale house.....	100.38	88.21	188.59	879 cu. ft.	0.22

Trestles to Receiving Bins

7314	Excavation.....	548.18	.....	548.18	589 cu. yd.	0.93
.1	Foundation.....	2,408.16	3,017.95	5,426.11	754.3 "	7.19
.2	Steel structure.....	.....	.....	9,269.48	109.35 tons	84.77
.3	Woodwork.....	572.23	838.11	1,410.34	27.21 m.b.m.	51.83

Total cost—Yard tracks and industrial system..... $156,326.43

7400.—Receiving Bins

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
7401	Excavation	$2,303.11	$39.16	$2,342.27	1,428 cu. yd.	$1.64
7402	Foundation	1,235.51	2,247.70	3,483.21	612.3 "	5.69
7403	Steel structure	.....	.....	29,276.63	353.09 tons	82.92
7404	Gates	901.15	1,984.93	2,886.08	30 gates	96.20
7405	Conveyor No. 1	310.92	2,947.19	3,258.11	97.3 ft.	33.49
.01	Conveyor No. 2	355.19	2,498.03	2,853.22	117.3 ft.	24.33
7407	Lighting	60.87	24.67	85.54	22 drops	3.89
	Total cost—Receiving bins			$44,185.06		

7700.—Crushing Plant

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
7701	Excavation	$689.67	.....	$689.67	609 cu. yd.	$1.13
7702	Foundation	893.15	$1,568.47	2,461.62	220.5 "	11.16
7703	Steel structure	.....	.....	2,420.36	25.07 tons	96.54
.1	Doors, windows and frames	84.00	170.71	254.71	529 sq. ft. opening	0.48
.2	Painting woodwork	15.00	12.33	27.33	70 sq. yd.	0.39
7704	Crushing machinery	392.86	1,093.61	1,486.47	500 cwt.	2.97
.1	Chutes	325.87	338.09	663.96	118.1 cwt.	5.62
7705	Shafting, pulleys and belting	4.17	483.35	487.52	12 lin. ft.	.....
7706	Motor	102.81	513.64	616.45	50 h.p.	12.33
7707	Power wiring	26.55	19.35	45.90	.....	.....
.1	Lighting	76.41	38.22	114.63	8 drops	14.33
	Total cost—Crushing plant			$9,268.62		

7800.—Sampling Plant

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
7801	Excavation	$274.09	$20.97	$295.06	332 cu. yd.	$0.89
7802	Foundation	605.91	649.44	1,255.35	120.7 "	10.40
.1	Concrete ground floor	105.68	263.92	369.60	1,222 sq. ft.	0.30
.2	Reinforced concrete floors	1,050.61	1,080.30	2,130.91	4,244 "	0.50
7803	Steel structure	.....	.....	10,408.12	110.85 tons	93.89
.1	Doors, windows and frames	332.94	564.90	897.84	2,086 sq. ft. opening	0.43
.11	Painting doors and windows	118.94	28.96	147.90	129 sash	1.15
7804	Shafting, pulleys and belting	64.01	1,871.07	1,935.08	85 ft. of shafting	22.76
7805	Meters	186.76	887.57	1,074.33	90 h.p.	11.94
7806	Power wiring	78.11	120.55	198.66	.....	.....
.1	Lighting	184.45	140.57	325.02	36 drops	9.03
7807	Rolls and samplers, cost and erection	1,215.83	7,899.14	9,114.97	1,251.1 cwt.	7.29
.1	Cast iron liners and drying pan, and erection of chutes	1,240.69	1,001.86	2,242.55	270.6 cwt.	8.29
.20	Elevator	20.39	458.22	478.61	1 elevator	478.61
.50	Steel chutes (made at new smelter)	1,995.70	596.65	2,592.35	198 cwt.	13.09
7809	Keystone plate partitions	131.04	338.32	469.36	1,523 sq. ft.	0.31
7810	Alterations of chutes and machinery	128.69	44.34	173.03	.....	.....
	Total cost—Sampling plant			$34,108.74		

7900.—Bedding Plant and Bunker Bins

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
7901	Excavation	$11,577.53	$681.90	$12,259.43	12,319 cu. yd.	$0.99
7902	Foundation	6,256.34	14,513.21	20,769.55	2,809.7 "	7.39
7903	Steel structure	.....	.....	47,404.86	548.71 tons	86.39
7904	Conveyors 7^1–7^2	564.34	6,373.67	6,938.01	380.2 ft.	18.24
.1	" 8^1–8^2–8^3	1,211.01	8,718.98	9,929.99	562 ft.	17.67
.2	" 9^1–9^2–9^3–10^1–10^2	1,912.20	9,756.19	11,668.39	905.5 ft.	12.88
.3	Bunker bin gates	161.58	1,021.64	1,183.22	42 gates	28.17
.4	Chutes for conveyors 7^1 to 10^2 inc.	658.91	842.60	1,501.51	276.2 cwt.	5.44
7905	Two reclaimers	3,103.28	30,579.45	33,682.73	2 reclaimers	16,841.37
.1	" wiring	377.21	131.19	508.40	2 "	254.20
7906	Lighting	306.85	127.38	434.23	63 drops	6.89
7907	Transfer car	739.12	3,823.19	4,562.31	1 car	4,562.31
7908	Signal system	67.68	28.74	96.42	.....	.....
	Total cost—Bedding plant and bunker bins			$150,939.05		

8100.—Roasting Plant

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
8101	Excavation	$1,547.07	.....	$1,547.07	1,216 cu. yd.	$1.27
8102	Foundation	765.42	1,069.63	1,835.05	250.5 "	7.33
8103	Steel structure	.....	.....	37,252.67	445.28 tons	83.66
.1	Elevator	.....	.....	2,189.62	5 tons capacity	437.92
8104	Roasters, cost and erection	3,716.94	56,326.09	60,043.03	8 roasters	7,505.38
.1	" alterations	620.49	81.69	702.18	.....	.....
8105	" brickwork	4,730.85	12,336.35	17,067.20	16,104 cu. ft.	1.06
.01	" unloading brick	363.14	.....	363.14	1,231.01 tons	0.29
.02	" centering for brickwork	1,389.62	588.25	1,977.87	8 roasters	247.23
8106.01	Roaster flue, spouts	116.52	568.99	685.51	10 spouts	68.55
.02	" " tile work	374.82	400.36	775.18	2,365 cu. ft.	0.33
.03	" " painting inside	8.50	3.97	12.47	73 sq. yd.	0.17
8107	Shafting, pulleys and belting	118.24	1,999.89	2,118.13	164 lin. ft.	12.92
8108	Motor	277.08	463.96	741.04	30 h.p.	24.70
8109	Lighting	340.64	157.70	498.34	67 drops	7.44
8112	Motor-driven fans	77.69	1,405.91	1,483.60	2 fans	741.80
8112.1	Blast pipe from fans to roaster	1,569.62	656.62	2,226.24	240 ft.	9.28
8113	Conveyor No. 12	164.15	805.05	969.20	51.2 ft.	18.93
.1	" 13^1 and 13^2	476.29	3,472.23	3,948.62	217.3 ft.	18.17
.2	Stile over conveyors	98.91	199.80	298.71	2.40 tons	124.46
	Total cost—Roasting plant			$136,734.87		

8120.—Roaster Dust Chamber

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
8121	Excavation	$918.74	$194.09	$1,112.83	1,194 cu. yd.	$0.93
8122	Foundation	1,049.71	1,775.05	2,824.76	472.9 "	5.97
8123	Steel structure	.....	.....	34,745.41	415.68 tons	83.59
.01	Wire baffles	523.63	4,758.23	5,281.86	604.8 c. wires	8.73
.1	Tile work	2,268.29	2,585.45	4,853.74	14,980 cu. ft.	0.33
.11	Unloading tile	307.72	.....	307.72	525.05 tons	0.59
.2	Painting outside	304.75	115.82	420.57	2,851 sq. yd.	0.15
.3	Painting inside	93.50	24.37	117.87	950 "	0.12
	Total cost—Roaster dust chamber			$49,664.76		

8300.—Reverberatory Plant

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
8301	Excavation	$1,417.88	$59.78	$1,477.66	1,890 cu. yd.	$0.78
.01	Back filling	2,742.44	13.11	2,755.55	3,679 "	0.75
8302	Foundation	7,715.96	15,044.09	22,760.05	2,810 "	8.10
.1	Concrete counterweights.	88.22	79.27	167.49	8.5 "	19.71
8303	Steel structure	.....	.....	40,799.76	461.09 tons	88.48
8304	Reverberatories, brickwork	8,402.75	34,963.88	43,366.63	29,680 cu. ft.	1.46
.01	" unloading brick	934.78	329.71	1,264.49	2,279.49 tons	0.55
.02	" centering	859.77	547.78	1,407.55	3 reverbera-tories	469.18
.05	" rehandling brick	1,503.85	.....	1,503.85	1,530.92 tons	0.98
.1	" steel work	1,366.38	14,552.71	15,919.09	240 tons	66.33
.2	" silica fill	3,715.66	5,689.41	9,405.07	1,231.49 tons	7.64
.3	" hoppers and chutes.	150.08	1,263.59	1,413.67	403.35 cwt.	3.51
8305	Cross and header flues, brickwork	3,296.65	15,098.97	18,395.62	18,500 cu. ft.	0.99
.01	" unloading brick	403.77	93.83	497.60	1,329.23 tons	0.37
.02	" centering	316.84	125.97	442.81	3 sets	147.60
.2	" painting brick	46.88	21.45	68.33	473 sq. yd.	0.15
8306	Flues from boilers to reverberatory, flue excavation	19.86	.....	19.86	15 cu. yd.	1.32
.1	" foundation	74.22	74.02	148.24	9.2 "	16.11
.2	" steel structure	.....	.....	2,815.32	34.78 tons	80.95
8307	Reverb. boiler bldg. excav'n	283.14	.....	283.14	306 cu. yd.	0.93
.01	Waste heat boilers "	213.44	.....	213.44	129 "	1.65
.02	Oil-fired boilers "	73.60	.....	73.60	97 "	0.76
.03	Boiler feed pumps "	591.28	10.16	601.44	659 "	0.91
.04	Backfill, back of boiler wall	518.10	30.00	548.10	972 "	0.56
.1	Boiler building foundations	2,181.08	3,846.18	6,027.26	573.7 "	10.51
.11	Waste heat boilers "	789.52	793.97	1,583.49	138.7 "	11.42
.12	Oil-fired boilers "	350.45	686.29	1,036.74	100 "	10.37
.13	Feed pumps foundation	678.73	1,428.97	2,107.70	214.7 "	9.82
.2	Floor over slag track cut	1,018.17	1,687.29	2,705.46	7,676 sq. ft.	0.35
.3	Floor around boilers	276.29	664.82	941.11	2,705 "	0.35
8308	Boiler building, steel structure	.....	.....	25,839.85	292.03 tons	88.48
.5	Platform and brackets	1,317.18	2,556.45	3,873.63	29.50 tons	131.30
8309	Waste heat boilers, inc. all steel	4,078.19	30,335.30	42,413.49	7 boilers	6,059.07
.01	" " brickwork	3,878.57	13,749.97	17,628.54	18,025 cu. ft.	0.98
.02	" " unloading brick	510.74	8.17	518.91	1,073.74tons	0.48
.03	" " painting	140.53	84.29	224.82	1,190 sq. yd.	0.19
.05	" " rehandling brick	185.76	.....	185.76	1,135.57 tons	0.16
.1	Oil fired boilers, inc. all steel	1,892.22	13,125.78	15,018.00	3 boilers	5,006.00
.11	" " brickwork	1,697.31	1,154.62	2,851.93	6,561 cu. ft.	0.43
.12	" " unloading brick	168.44	15.50	183.94	228.11 tons	0.81
.13	" " painting	124.59	24.16	148.75	438 sq. yd.	0.34
.15	" " rehandling brick	137.06	.....	137.06	413.35 tons	0.33
8310	Superheaters waste heat boilers	654.41	8,288.71	8,943.12	7 heaters	1,277.58
.1	" oil fired boilers	280.28	2,756.41	3,036.69	3 boilers	1,012.23
8312	Misc. piping boilers and reverb. bldg.	524.15	1,409.85	1,934.00	.....	.....
.1	Feed piping from heating plant to feed pumps	1,039.91	51.51	1,091.42	1,296 cu. yd.	0.84
.11	" " from conduit and pipe	386.25	2,757.79	3,144.04	557 ft.	5.64

8300.—Reverberatory Plant (*Continued*)

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
8312.20	" " from pumps to boilers	1,060.53	3,041.00	4,101.53	1,093 ft.	3.75
.50	Blow-off piping and drum.	145.32	527.77	673.09	.....	.....
8313	Wiring electrical feed pumps	135.45	177.89	313.34	2 pumps	156.67
.1	Lighting for reverb. and boiler bldg	612.30	473.19	1,085.49	104 drops	10.45
8314	Slag launders	433.20	1,157.80	1,591.00	72 ft.	22.10
8315	Matte launders	142.66	1,209.08	1,351.74	304 ft.	4.44
8316	Six No. 14 Wilgus oil systems	111.48	1,862.29	1,973.77	6 pumps	328.96
8317	Two electrical feed pumps.	240.25	5,633.97	5,874.22	2 "	2,937.11
.1	One steam feed pump	37.27	499.24	536.51	1 "	536.51
.2	Crawls and chain block in feed pump house	2.00	112.05	114.05	.....	.....
8318	Fettling system	1,463.13	1,943.08	3,406.21	3 furnaces	1,135.40
	Total cost—Reverberatory plant			$328,945.02		

8400.—Converter Plant

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
8401	Excavation	5,163.74	567.37	5,731.11	6,330 cu. yd.	0.91
8402	Foundation	1,796.56	2,860.16	4,656.72	776.9 cu. yd.	6.00
8403	Steel structure	.....	.....	69,359.60	783.86 tons	88.48
8404	Converter stands—Excavation.	255.48	3.40	258.88	304 cu. yd.	0.85
.1	" " —foundation.	555.53	1,331.03	1,886.56	173.8 cu. yd.	10.85
8405	" " and shells	821.67	22,238.28	23,059.95	162.53 tons	141.88
.01	Repairs to No. 2 stand	164.44	9.53	173.97	.....	.....
.1	Converter shells—brick lining	785.61	8,043.00	8,828.61	4 shells	2,207.15
.11	" " —unloading brick.	104.22	82.03	186.25	579.30 tons	0.32
8406	Cranes	1,438.50	23,027.65	24,466.15	110.75 tons	220.91
.1	" wiring	1,941.44	342.62	2,284.06	2 cranes	1,142.03
8407	Clinkering machines	1,715.23	13,981.94	15,698.17	2 machines	7,640.71
.01	" " alteration No. 1	33.00	1.43	34.43	.....	.....
.02	" " alteration No. 2.	57.92	40.39	98.31	.....	.....
.03	Clinkering machine electrical alteration	65.98	31.10	97.08	.....	.....
.1	Clinkering machines, wiring	392.21	283.79	676.00	2 machines	338.00
8409	Wiring for converter control	136.42	318.49	454.91	3 converters	151.64
.1	Lighting	451.93	462.01	913.94	60 drops	15.23
8410	Air pipe from power house excav	224.06	.....	224.06	331 cu. yd.	0.68
.1	Air pipe from power house laying	674.62	2,041.89	2,716.51	422 ft.	6.43
8411	Ladles, boats, bales, tools, etc	906.82	4,932.39	5,839.21	.....	.....

8400.—Converter Plant (*Continued*)

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
8413	Casting machine excavation...	490.39	30.43	520.82	512 cu. yd.	1.02
8414	" " foundation...	1,627.37	1,889.36	3,516.73	291.9 cu. yd.	12.05
8415	" " cost and erection.	3,266.34	24,211.21	27,477.55	2 machines	13,738.7
.1	" " repairs..	221.71	13.88	235.59	.....	.....
8416	Loading platform excavation.	212.49	.28	212.77	216 cu. yd.	0.99
.1	" " foundation...	311.35	505.68	817.03	93.2 cu. yd.	8.77
.11	" " floors...	381.02	1,053.55	1,434.57	6,803 sq. ft.	0.21
.2	" " backfill.	67.85	.....	67.85	129 cu. yd.	0.53
.3	" " striking plates..	53.09	126.69	179.78	119 sq. ft.	1.51
8417	Hoods and smoke boxes..	2,674.30	4,012.59	6,686.89	3 sets	2,228.96
.1	Hood to protect converter operator.....	62.67	109.66	172.33	1 hood	172.33
8418	Spouts, gates and hoppers at Silica ore bins.....	245.48	1,400.37	1,645.85	.....	.....
8419.1	10-ton bullion scales excavation.....	19.76	.....	19.76	24 cu. yd.	0.82
.2	" " " foundation.....	58.32	65.19	123.51	10.5 cu. yd.	11.76
.3	" " " cost and erection.....	55.55	736.53	792.08	10 tons	79.21
.4	" " " scale house.....	48.78	41.09	89.87	1 shed	89.87
8425	Conveyor No. 15.....	422.77	2,251.47	2,674.24	165 ft.	16.21
8426.1	Wet pan excavation.....	2.44	.....	2.44	3 cu. yd.	0.81
.2	" " foundation.....	53.30	55.96	109.26	7.5 cu. yd.	14.57
.3	" " cost and erection.	304.76	1,050.10	1,354.86	1 pan	1,354.86
.4	" " bin and spout...	75.64	180.47	256.11	548 cwt.	4.67
	Total cost converter plant	.....	.....	$216,033.37	.....	.....

8420.—Converter Dust Chamber

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
8421	Excavation.....	$127.28	.....	$127.28	265 cu. yd.	$0.48
8422	Foundation.....	668.85	1239.17	1,908.02	286.4 cu. yd.	6.66
8423	Steel structure.....	.....	.....	20,371.20	238.30 tons	85.49
.01	Wire baffles.....	138.86	1,101.95	1,240.81	166.10 c. wire	7.47
.1	Tile work.....	1,620.05	2,182.40	3,802.45	6,369 cu. ft.	0.60
.11	Tile handling.....	37.61	.....	37.61	155.20 tons	0.24
8424	Iron doors and frames....	1.94	158.93	160.87	.....	.....
8428	Smoke box track.....	155.32	10.02	165.34	.....	.....
	Total cost converter dust chamber.....	.....	.....	$27,813.58	.....	.....

8500.—Conveying System

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
8501	Excavation	$1,824.22	.....	1,824.22	2,286 cu. yd.	$0.80
8502	Foundation	2,550.78	4,006.37	6,557.15	622.3 cu. yd.	10.54
8503	Steel structure	.....	.....	19,365.98	211.73 tons	91.47
8504	Woodwork	589.51	630.42	1,219.93	13.86 m.b.m.	88.02
.1	Floor battens	146.29	51.47	197.76	.....	.....
8505	Conveyors No.'s 3–4–5–6 11–14	1,210.87	12,505.62	13,716.49	1,284.9 ft.	10.68
.1	Chutes	665.15	167.13	832.28	23.3 cwt.	3.67
.2	Guides	28.00	.....	28.00	.....	.....
.3	Weightometer	65.00	1,329.92	1,394.92	1 weighto-meter	1,994.92
8506	Lighting	189.86	84.56	274.42	33 drops	8.32
	Total cost—Conveying system	.....	.....	$4,5411.15	.....	.....

8600.—Chimney

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
8601	Excavation	$337.44	$29.61	$367.05	597 cu. yd.	$0.61
8602	Foundation	654.42	4,199.65	4,854.07	872.7 cu. yd.	5.56
8603	Brickwork	891.88	39,358.34	40,250.22	58,644 cu. ft.	0.69
	Total cost chimney	.....	.....	$45,471.34	.....	.....

8610.—Reverberatory Flue

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
8611	Excavation	$916.72	$20.21	$936.93	1,588 cu. yd.	$0.59
8612	Foundation	1,657.09	3,886.80	5,543.89	487.8 cu. yd.	11.37
8613	Brickwork	1,272.86	1,696.39	2,969.25	6,400 cu. ft.	0.46
.01	Unloading brick	57.79	.....	57.79	278.33 tons	0.21
8614	Steel structure	.....	.....	3,593.06	41.61 tons	86.35
.1	Clean out doors	10.61	153.61	164.22	.....	.....
.2	Caulking roof	184.35	4.21	188.56	.....	.....
	Total cost—Reverberatory flue	.....	.....	$13,453.70	.....	

8620.—Converter Flue

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
8621	Excavation	$168.02	.....	$168.02	198 cu. yd.	$0.85
8622	Foundation	165.73	652.69	818.42	142 cu. yd.	5.76
8624	Steel structure	.....	.....	6,616.44	81.99 tons	80.70
	Total cost—Converter flue	.....	.....	$7,602.88	.....	

8625.—Roaster Dust Chamber Flue

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
8626	Excavation	$225.37	.....	$225.37	213 cu. yd.	$1.06
8627	Foundation	224.35	551.23	775.58	114.6 cu. yd.	6.77
8628	Brickwork	1,018.13	1,573.06	2,591.19	4,231 cu. ft.	0.61
.01	Unloading brick	57.60	.....	57.60	171.40 tons	0.34
8629	Steel structure	.....	.....	9,209.36	94.46 tons	97.49
	Total cost—Roaster dust chamber flue	.....	.....	$12,859.10	.....	.....

8700.—Boiler and Blacksmith Shop

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
8701	Excavation	$1,142.07	$44.81	$1,186.88	1,458 cu. yd.	$0.81
8702	Foundation	416.57	584.49	1,001.06	78.7 cu. yd.	12.71
8703	Steel structure	.....	.....	2,913.90	32.72 tons	89.06
.1	Doors, windows and frames	693.02	2,456.28	3,149.30	2,581 sq. ft. opening	1.22
.11	Concrete sills	119.80	50.87	170.67	251.5 lin. ft.	0.68
.2	Tile walls	477.95	612.62	1,090.57	2,297 cu. ft.	0.48
.21	Unloading tile	18.89	.....	18.89	69.70 tons	0.27
.22	Coping	112.17	2.72	114.89	290 lin. ft.	0.40
.30	Roof	286.52	828.24	1,114.76	66.49 squares	16.77
8703.31	Ventilators	16.01	261.50	277.51	3 vents	92.50
.40	Dirt floor	59.73	1.25	60.98	.....	.....
.50	Benches	87.83	49.43	137.26	.....	.....
.60	Painting	92.53	60.73	153.26	1,574 sq. yd.	0.10
8704	Crane	119.60	438.41	558.01	1 crane	558.01
8705	Tools	798.51	7,859.36	8,655.87	.....	.....
8706	Shafting, pulleys, belting	105.59	301.16	406.75	51 lin. ft.	7.98
8707	Motor	23.22	347.54	370.76	20 h.p.	18.54
8708	Lighting	23.41	44.50	67.91	17 drops	4.00
	Total cost—Boiler and blacksmith shop	.....	.....	$21,449.23		

8714.—Machine and Carpenter Shop

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
8715	Excavation	$1,615.83	$325.28	$1,941.11	1,765 cu. yd.	$1.10
8716	Foundation	792.05	584.06	1,376.11	105.5 cu. yd.	13.04
8717	Steel structure	.....	.....	3,431.42	38.23 tons	89.76
.1	Doors, windows and frames	923.61	2,992.16	3,915.77	3,037 sq. ft. opening	1.29
.11	Concrete sills	111.65	67.70	179.35	295.3 lin' ft.	0.61
.2	Tile walls	531.45	571.28	1,102.73	2,397 cu. ft.	0.46
.21	Unloading tile	42.06	2.00	44.06	58.80 tons	0.75
.22	Wall coping	121.67	23.70	145.37	320 lin. ft.	0.45
.30	Roof	297.85	953.04	1,250.89	77.21 squares	16.20
.31	Ventilators	11.16	248.24	259.40	3 ventilators	86.45
.40	Floor	269.80	593.30	863.10	4,136 sq. ft.	0.21
.50	Benches	130.00	35.00	165.00	.....	.....
.60	Painting	118.00	87.40	205.40	1,989 sq. yd.	0.10
8718	Crane	25.19	564.36	589.55	.....	.....
8719	Tools	444.07	8,953.13	9,397.20	.....	.....
8720	Shafting, pulleys and belting	289.29	1,513.36	1,802.65	152 lin. ft.	11.86
8721	Motor	18.34	477.97	496.31	40 h.p.	12.40
8722	Lighting	55.84	135.01	190.85	20 drops	9.54
	Total cost—Machine and carpenter shop	.....	.....	$27,356.27		

8800.—General Office

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
8804	Furniture and fixtures	.....	$1,394.95	$1,394.95	.....	.....

8809.—Warehouse

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
8810	Excavation	$944.59	$51.49	$996.08	1,287 cu. yd.	$0.77
8811	Foundation	878.16	856.09	1,734.25	123 cu. yd.	14.09
8812	Steel structure	.....	.....	3,734.08	39.76 tons	93.92
.1	Doors, windows and frames	533.02	1,056.31	1,589.33	1,982 sq. ft. opening	0.80
.11	Concrete sills	164.72	61.63	226.35	241.5 lin. ft.	0.94
.2	Tile walls	438.00	477.86	915.86	2,342 cu. ft.	0.39
.21	Unloading tile	15.50	1.00	16.50	74.20 tons	0.22
.22	Coping	176.60	36.53	213.13	320 lin. ft.	0.67
.3	Painting roof	81.16	65.66	146.82	813 sq. ft.	0.18
.31	Ventilators	30.38	207.12	237.50	3 vents	79.17
.4	Floor excavation	129.03	.....	129.03	66 cu. yd.	1.96
.41	" concrete	558.04	721.60	1,279.64	8,298 sq. ft.	0.15
.5	Lighting	45.09	70.48	115.57	26 drops	4.45
8813	Warehouse fixtures	548.66	1,541.12	2,089.78	.....	.....
.1	Painting	26.50	14.17	40.67	412 sq. yd.	0.10
.11	" sash	122.78	15.34	138.12	189 sash	0.73
	Total cost—Warehouse			$13,602.71		

8819.—Laboratory

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
8820	Excavation	$191.11	$0.16	$191.27	212 cu. yd.	$0.90
8821	Foundation	448.42	575.13	1,023.55	96.5 cu. yd.	10.61
.1	Plain concrete floors	113.78	154.90	268.68	1,026 sq. ft.	0.26
.2	Reinforced floors	59.81	114.87	174.68	364 sq. ft.	0.48
.3	Sills and lintels	109.53	22.85	132.38	163 lin. ft.	0.81
8822	Tile walls	250.71	517.66	768.37	841 cu. ft.	0.91
.2	Carpenter work	194.43	338.16	532.59	.....	.....
.5	Doors, windows and skylights	208.70	480.33	689.03	823 sq. ft. opening	0.84
8824	Wood fixtures	486.90	204.02	690.92	.....	.....
8825	Lighting	226.77	61.28	288.05	.....	.....
8826	Plumbing	129.79	97.23	227.02	.....	.....
8828	Painting	151.46	55.05	206.51	.....	.....
8829	Plastering	58.11	30.55	88.66	171.5 sq. yd.	0.52
8830	Apparatus	44.82	618.98	663.80	.....	.....
8831	Oil centrifuge	40.92	157.59	198.51	.....	.....
	Total cost—Laboratory			$6,144.02		

8840.—Sample Room

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
8841	Excavation	$61.35	.....	$61.35	72 cu. yd.	$0.85
8842	Foundation	61.00	64.43	125.43	9 cu. yd.	13.94
.1	Concrete floors	63.17	75.25	138.42	489 sq. ft.	0.28
8843	Walls and roof structure	101.84	201.81	303.65	.....	.....
.4	Roof	23.00	76.57	99.57	8 squares	12.45
.5	Doors and windows	32.39	118.85	151.24	298 sq. ft. opening	0.51
8844	Oven	233.74	58.56	292.30	.....	.....
8845	Benches, motor platform and fixtures	128.35	129.60	257.95	.....	.....
8846	Lighting	22.97	52.83	75.80	7 drops	10.82
8848	Painting	28.00	8.00	36.00	26 sash	1.38
8849	Machinery	53.07	912.00	965.07	.....	.....
.1	Motor	9.00	116.77	125.77	5 h.p.	25.15
.2	Shafting, pulleys and belting	23.39	170.17	193.56	26 lin. ft.	7.44
	Total cost—Sample room			$2,826.11		

8900.—Miscellaneous Accounts

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
8902	Sewer system, cost of pipe and laying	$778.83	$1,224.72	$2,003.55	2,967 ft.	$0.68
.1	" excavation	2,122.84	65.20	2,188.04	2,967 ft.	0.74
.2	" concrete	168.18	184.08	352.26	53.8 ft.	6.55
8903	Outside closets	879.05	227.78	1,106.83	3 closets	368.94
8905	Permanent outside lighting	183.02	177.99	361.01	5 acres	72.20
8906	Water pipe lines excavation	868.11	.....	868.11	4,253 ft.	0.20
.01	" concrete	17.37	17.86	35.23	2.3 cu. yd.	15.32
.02	" cost and laying	2,863.32	2,062.07	4,925.39	4,253 ft.	1.16
.1	6-in. pipe line to Clifton	1,474.71	6,914.95	8,389.66	8,988 ft.	0.93
.2	Water supply tank, excavation.	143.68	.....	143.68	116 cu. yd.	1.24
.4	" cost and erection	.....	.....	4,137.03	33.67 tons	122.87
8908	Power distribution	3,233.02	7,407.21	10,640.23	17,370 ft.	0.61
8909	Permanent air line, excavation	267.50	.....	267.50	401 cu. yd.	0.67
.1	" laying	432.37	623.08	1,055.45	2,316 ft.	0.46
8961	Steam heating system, excavation	166.36	.....	166.36	225 cu. yd.	0.73
.1	" cost and installation	240.78	305.37	546.15	496 ft.	1.10
	Total cost—Miscellaneous accounts			$37,186.48		

8999.—Charges to Indirect Expense

Number	Name of Account	Total
7001	General expense at Clifton	$13.58
7004	Personal injuries	6,734.01
8901	Derricks and construction equipment	18,718.35
8904	Telephone system	3,229.40
8905.1	Temporary outside lighting	18.30
8907	Watchman	1,516.69
8908.1	Temporary oil tanks	382.75
8910	Transmission of power to various departments	.....
8911	Watchman's house	185.39
8912	Tool shed	725.75
8913	Barn and corral	2,100.53
8914	Temporary blacksmith shop	251.71
8916	" power plant	5,518.11
8917	" crushing plant	4,555.07
8918	" water tank	1,991.31
8919	" electrical shop equipment	322.16
8920	Wagon roads	1,215.33
8921	Temporary pumping plant	375.25
8922	" pipe lines	5,199.73
8923	" warehouse	1,810.24
8924	" cement sheds	801.10
8925	Horses, harness and carts	2,646.40
8926	Temporary office	1,195.86
8927	" closets	146.65
8928	" machine shop	166.10
8929	Employes railroad transportation	16,994.57
8930	Clearing land	456.67
8931	Test holes	109.48
8933	Furniture and fixtures	365.25
8934	Miscellaneous supplies	4,436.24
8935	Shop equipment	657.68
8936	Overhead shop expense	8,394.19
8937	Stock lumber	.....
8938	Powder magazine	241.37
8939	Miscellaneous labor	6,825.89
8941	Temporary railway receiving bins	243.78
8942	Water supply	2,372.63
8943	Corral expense	.....
8944	Switching and freight from Clifton	2,661.35
8945	Office stationery and supplies	1,369.68
8946	Warehouse operating expense	10,771.88
8947	Time-keeping expense	4,346.59
8948	Form lumber	.....
8949	Cement	.....
8951	Sand and gravel	.....
8952	Employes quarters	2,192.98
8953	Crushing plant operating expense	.....
8954	Concrete, power and repairs	.....
8955	Mortar sand	.....
8955.1	Mortar lime	.....
8955.2	Mortar cement	.....
8955.4	Fire brick mortar	.....
8955.5	Silica brick mortar	.....
8956	Operating temporary power house	.....
8957	Maintenance of tracks in yards	2,800.31
8958	Ditch at tunnel No. 2	5,851.89
8975	Cleaning up	4,996.20
8976	Rehandling brick and tile	53.02
8998	Direct charges	4,316.30
8999	Total charges to indirect expense	$140,277.72
	Total unit cost	7.53 per cent.

This percentage is obtained by dividing the total charges to indirect expense by the total cost of the smelter, minus engineering and indirect expense.

$$\frac{\$140,277.72}{1,864,092.47} = 7.53 \text{ per cent.}$$

9000. Power Plant

Power House

Number	Name of Account	Labor	Material	Total	Quantity	Tot Un Co
9000.1	Power plant engineering	.....	.....	.....	.....	See page
9001	Excavation.....	$7,727.56	$69.09	$7,796.65	7,313 cu. yd.	$
9002	Bldg. foundation piers.	1,699.92	1,460.02	3,159.94	231.7 cu. yd.	1
.1	" " walls	3,735.78	3,628.81	7,364.59	508.5 cu. yd.	1
.2	North tunnel.....	1,350.79	1,230.37	2,581.16	180.3 cu. yd.	1
.3	Concrete drain.....	205.68	227.37	433.05	31.6 cu. yd.	1
.4	Basement floor, concrete.....	916.41	1,347.78	2,264.19	12,130 sq. ft.	
.45	" painting.....	81.45	48.81	130.26	830 sq. yd.	
.6	Preparation of concrete for painting.....	891.73	42.69	934.42	2,459 sq. yd.	
.7	Painting concrete.....	195.84	301.61	497.45	2,459 sq. yd.	
9003	Steel structure.....	.....	.....	23,773.30	254.29 tons	9
.1	Tile walls.....	3,856.83	4,510.20	8,367.03	14,343 cu. ft.	
.11	Unloading tile.....	332.40	0.17	332.57	52.2 tons	
.12	Wall coping.....	372.69	107.05	479.74	732 lin. ft	
.2	Doors, window and frames.....	974.38	3,319.93	4,294.31	4,044 sq. ft. opening	
9003.21	Concrete sills.....	596.33	120.96	717.29	964 lin. ft	9
.3	Ventilators.....	125.60	439.76	565.36	6 ventilators	
.4	Main floor columns...	236.93	626.44	863.37	68 columns	1
.41	Main floor slab concrete.....	1,267.91	3,341.61	4,609.52	10,210 sq. ft	
.42	Painting under side main floor.....	181.88	147.58	329.46	2,059 sq. yd	
.43	" top main floor...	95.56	199.32	294.88	1,134 sq. yd.	
.5	Roof, Berger multiplex plate.....	420.83	3,063.18	3,484.01	214.83 squares	1
.51	" concrete.....	1,723.10	958.51	2,681.61	214.83 "	1
.52	" tar.....	172.70	127.74	300.44	214.83 "	
.53	" down spouts and tile drain.....	286.17	240.44	526.61	905 ft	
.54	" painting underside.....	692.84	324.55	1,017.39	6,841 sq. yd	
.55	" P. & B. roofing .	577.08	1,317.08	1,894.76	214.83 squares	
.60	Painting sash.....	290.09	10.72	300.81	209 sash	
.61	Painting woodwork...	29.50	4.06	33.56	89 sq. yd	
9004	Crane.....	131.89	1,724.27	1,856.16	1 crane	1,85
9005	Well grading.....	1,558.07	517.08	2,075.75	2,000 cu. yd	
.1.	Shaft sinking.....	765.63	612.10	1,377.73	45 ft	3
.2	Timbering.....	57.61	.....	57.61	45 ft	
.31	Aldrich pump installation.....	74.56	16.62	91.18	.....	.....
9006.01	Nordberg blowers, foundation.....	774.06	3,020.83	1,794.89	600 cu. yd.	
.1	" cost and installation.....	1,641.62	32,514.02	34,155.64	2 No. Blowers	17,07
.2	" painting.....	327.57	57.65	385.22	2 "	19
9007.01	Turbines, foundation .	959.08	1,432.70	2,391.78	106.5 cu. yd.	1
.1	" cost and installation.....	2,297.70	79,586.49	81,884.19	3 turbines	27,29
.2	" painting.....	286.15	41.02	327.17	3 "	10
.3	" air pipe ranking..	547.68	200.75	748.43	101 ft	
.4	" air pipe erection.	202.57	83.24	285.81	101 ft	
.51	Transformer trucks and transfer table...	121.63	538.08	659.71	15 trucks	4
.52	Auto transformers....	735.60	12,044.91	12,780.51	10 transformers	1,27
9008. 01	Condensers foundations.....	391.08	285.18	676.26	59.3 cu. yd	1

9000.—Power Plant (*Continued*)

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
9008.1	" cost and installation	415.31	19,563.55	19,978.86	3 condensers	6,659.62
.2	" painting	30.00	5.86	35.86	3 "	11.95
9009	Jet condenser hot well, excavation	28.82	0.90	29.72	46 cu. yd.	0.65
.01	" foundation	66.27	69.99	136.26	16.5 "	8.26
.02	" supporting struct. and tank	.....	.....	945.74	5.76 tons	164.19
.03	" cost and erection	128.97	949.68	1,078.65	1 condenser	1,078.65
.12	" dry vacuum pumps	285.51	2,860.01	3,145.52	2 pumps	1,572.76
.13	" " painting	30.00	5.86	35.86	2 "	17.93
.21	Circulating pumps foundation	560.04	708.93	1,268.97	210 cu. yd.	6.04
.22	" cost and erection	366.90	3,535.68	3,902.58	2 pumps	1,951.29
.23	" painting	30.00	5.86	35.86	2 "	17.93
9010.01	Air compressor foundation	840.98	1,246.54	2,087.52	238.3 cu. yd.	8.76
.02	" erection	642.90	148.67	791.57	.....	.....
.03	" painting	10.58	24.49	35.07	.....	.....
.04	" all piping except steam	298.46	160.65	459.11	.....	.....
.05	" wrecking and transportation	457.77	136.06	593.83	.....	.....
.06	" installation of air receivers	49.47	1.43	50.90	.....	.....
9011.01	2 exciters, 2 air pumps, 2 cir. pumps, found'n	1,439.67	1,875.43	3,315.10	373 cu. yd.	8.89
.02	2 exciters, cost and installation	491.01	6,118.26	6,609.27	2 exciters	3,304.64
.03	3 dry vacuum pumps, cost and installation	147.26	3,190.10	3,337.36	3 pumps	1,112.45
.04	3 cir. pumps and engines, cost and installation	389.32	8,729 37	9,118.69	3 "	3,039.56
.05	2 exciters, painting	86.01	14.65	100.66	2 exciters	50.33
.06	3 air pumps, "	50.00	8.79	58.79	3 pumps	19.59
.07	3 cir. " "	81.69	14.65	96.34	3 "	32.11
9012.01	2 motor gen., 1 air pump, 1 cir. pump., foundation	296.52	658.91	955.34	107 cu. yd.	8.93
.02	2 motor generators, cost and installation	319.06	6,830.33	7,149.39	2 generators	3,574.69
.05	" painting	30.00	5.86	35.86	2 "	17.93
9013	Transfer table pit, concrete	24.13	58.23	82.36	12 cu. yd.	6.86
.01	Switchboard concrete compartments	1,472.21	510.48	1,982.69	1,469 sq. ft.	1.35
.02	" cost and erection	2,730.53	15,520.57	18,251.10	.....	.....
9014	Steam piping north and south mains, excavation	249.65	.....	249.65	279 cu. yd.	0.89
.01	" " foundation	578.24	945.97	1,524.21	194.5 cu. yd.	7.84
.02	" steel supporting structure	.....	.....	7,694.58	86.81 tons	88.64
.03	" hangers and anchors	1,030.68	337.26	1,367.94	153 rods	8.94
.04	" cost and erection	2,286.31	18,622.25	20,908.56	3,401 ft.	6.15
.05	" covering and erection	266.71	5,813.23	6,079.94	3,401 ft.	1.79

9000.—Power Plant (*Continued*)

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
9015	Exhaust pipe, cost and erection	1,745.71	8,715.66	10,461.37	1,541 ft.	6.79
.01	" painting	85.05	51.19	136.24	1,541 ft.	0.09
.05	" covering and erection	318.25	830.56	1,148.81	746 ft.	1.54
.10	Air piping, cost and erection	363.19	554.16	917.35	.....	.....
.11	" painting	31.56	18.66	50.22	.....	.....
.2	Exhaust pipe foundation	63.09	102.81	165.90	18.3 cu. yd.	9.07
.21	" supporting structure	197.27	57.93	255.20	.....	.....
.22	" excavation	20.82	.....	20.82	29 cu. yd.	0.72
9016	Water pipe, excavation and backfill	1,485.10	0.24	1,485.34	2,406 cu. yd.	0.62
.01	" cost and erection	3,747.79	16,437.88	20,185.87	.....	.....
.02	" painting	230.59	25.54	256.13	.....	.....
	Feed-water Heating Power					
9017	Excavation	239.39	1.70	241.09	274 cu. yd.	10.88
.01	Foundation	708.06	551.04	1,259.10	105.4 cu. yd.	1.95
.015	Reinforced floors	282.45	273.51	555.97	1,330 sq. ft.	0.42
.016	Water-proofing concrete tanks	80.65	14.46	95.11	1,475 sq. ft.	80.06
.02	Steel structure	.....	.....	2,262.90	26.63 tons	4.98
.021	Distributing and equalizing tank	364.70	260.58	625.28	80.2 cwt.	7.80
.03	Tile work	285.99	234.36	520.35	706 cu. ft.	0.74
.031	Unloading tile	24.91	.....	24.91	30 tons	0.83
.032	Coping	14.83	14.01	28.84	108 lin. ft.	0.27
.033	Sills and lintels	7.81	5.57	13.38	60 lin. ft.	0.22
.034	Painting tile walls	26.10	.....	26.10	112 sq. yd.	0.23
9017.035	Doors, windows and frames	59.83	99.98	159.81	186 sq. ft. opening	0.86
.04	Roofing	115.25	109.88	225.13	8.8 squares	25.58
.045	Ventilators	142.14	49.20	191.34	2 ventilators	95.67
.05	Treating tank, concrete	637.67	487.19	1,124.86	28.7 cu. yd.	39.19
.06	Receiving tank No. 1.	251.55	167.92	419.47	7.3 cu. yd.	57.46
.07	Receiving tank No. 2..	364.50	265.08	629.58	24.4 cu. yd.	25.80
.08	Calibrating tank	188.96	50.21	239.17	12.6 cwt.	18.98
.081	Tipping meter	372.46	227.50	599.96	1 tipping meter	599.96
.09	Heaters, recorder	685.22	2,813.84	3,499.06	.....	.....
.1	Sewer excavation and backfill	157.19	.....	157.19	266 cu. yd.	0.59
.11	Sewer pipe, cost and laying	71.88	203.00	274.88	100 ft.	2.75
.12	Lighting	53.35	25.83	79.18	6 drops	13.20
.13	Painting	62.78	20.35	83.13	.....	.....
.14	Wood walkway and tank covers	67.08	51.31	118.39	1.56 m.b.m.	75.89
.15	Alterations	99.70	3.40	103.10	.....	.....
	Condensed Water Pump House					
.20	Excavation	220.56	8.93	229.49	236 cu. yd.	0.97
.21	Foundation	1,171.89	854.68	2,026.57	171 cu. yd.	11.85
.22	Floor	78.41	57.70	136.11	355 sq. ft.	0.38
.24	Doors, windows and frames	26.02	22.68	48.70	57 sq. ft. opening	0.85
.242	Tile work	98.87	84.28	183.15	257 cu. ft.	0.71
.243	Coping	14.50	2.73	17.23	57 lin. ft.	0.30
.25	Roof	73.92	60.83	134.75	5 squares	26.95
.26	Pumps and piping	90.58	691.37	781.95	2 pumps	390.98
.27	Lighting	221.16	51.53	272.69	.....	.....

Power House Miscellaneous Accounts

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
9018.1	Power and lighting transformers	397.70	4,714.33	5,112.03	7 transformers	730.29
9019	Lighting	307.86	1,449.97	1,757.83	94 drops	18.70
9020	Oiling system	1,051.82	401.69	1,453.51	104 outlets	13.98
9021	Benches, bolt racks, etc.	161.22	51.80	213.02	.....	.....
9022	Instruments and gauges	57.97	343.06	401.03	.....	.....

Cooling Tower

9050	Excavation	1,590.85	83.47	1,674.32	1,589 cu. yd.	1.05
.01	Backfill	1,395.20	.....	1,395.20	2,415 cu. yd.	0.58
9051	Foundations, sumps and gutters	5,212.31	5,640.13	10,852.44	706.3 cu. yd.	15.37
.02	Floor	911.93	1,985.03	2,896.96	17,116 sq. ft.	0.17
.03	Water proofing concrete	588.76	130.59	719.35	1,606 sq. yd.	0.45
9052	Woodwork	3,181.33	5,415.47	8,596.80	128.63 m.b.m.	66.84
9053	Alterations	115.40	22.54	137.94	.....	.....

Total cost—Cooling tower..... $26,273.01
Total cost—Power plant..... $434,703.15

9060.—Oil Supply Sump and Pump House

Number	Name of Account	Labor	Material	Total	Quantity	Total Unit Cost
9060	Excavation	$1,148.78	$108.24	$1,257.02	1,308 cu. yd.	$0.96
.01	Concrete work	2,338.72	3,230.46	5,569.18	340.6 cu. yd.	16.35
.02	Pumps	176.20	2,035.58	2,211.78	2 pumps	1,105.89
.03	Inlet piping	44.77	126.55	171.32	108 ft.	1.59
.04	Lighting	79.71	62.57	142.28	4 drops	35.57
.05	Steel work	96.94	129.39	226.33	1.12 tons	202.08
.06	Doors, windows and frames	83.60	65.02	148.62	124 sq. ft. opening	1.20
.07	Roof	136.81	162.66	299.47	6.5 squares	46.07
.075	Ventilators	95.75	64.32	160.07	2 ventilators	80.03

Two 500,000 Gallon Oil Tanks

9060.10	Wrecking and transportation	934.00	465.31	1,399.31	64.40 tons	21.73
.11	Excavation	308.20	.....	308.20	554 cu. yd.	0.56
.12	Foundation	128.70	210.61	339.31	32.8 cu. yd.	10.35
.13	Erection	3,602.89	429.47	4,032.36	64.40 tons	62.62
.131	Roof supports	362.90	359.83	722.73	65.56 squares	11.02
.132	Sheathing, lath and plaster	399.05	523.01	922.05	75.50 squares	12.22

Tracks at Oil Sump

9060.14	Railroad grading	1,477.27	.....	1,477.27	2,439 cu. yd.	0.61
.15	Laying and ballasting	1,107.38	1,092.99	2,200.37	1,362 ft.	1.62
.16	Track bumpers	246.74	47.92	294.66	3.16 m.b.m.	93.25
.17	Bridges over wood pipe	229.22	87.14	316.36	.....	.....

Oil Supply Tanks for Reverberatories and Boilers

9060.20	Excavation	392.13	13.18	405.31	404 cu. yd.	1.00
.21	Foundation	875.70	1,685.76	2,561.46	189.5 cu. yd.	13.52
.22	Cost and erection	.....	.....	3,926.67	8 tanks	487.94
.23	Piping	199.41	282.16	481.57	785 ft.	0.61

Oil Piping

9060.40	Excavation	990.73	1.39	992.12	1,150 cu. yd.	0.86
.41	Pipe and laying	3,156.14	5,654.50	8,810.64	1,888 ft.	4.67
9060.50	Heating installation	167.37	1,068.04	1,235.41	360 ft.	3.43

NEW SMELTER

Recapitulation of Costs

Number	Name of Account	Total $100,000 ss
7100	Engineering expense	
7300	Yard tracks and industrial system	136,326 43
7400	Receiving bins	14,183 06
7700	Crushing plant	9,208 62
7800	Sampling plant	34,108 74
7900	Bedding plant and bunker bins	150,030 05
8100	Roasting plant	130,734 87
8120	Roaster dust chamber	49,604 76
8300	Reverberatory plant	328,945 02
8400	Converter plant	210,033 37
8420	Converter dust chamber	27,814 58
8500	Conveying system	15,411 15
8000	Chimney	45,471 34
8610	Reverberatory flue	14,353 70
8620	Converter flue	7,092 88
8627	Roaster dust chamber flue	12,85
8703	Boiler and blacksmith shop	21,44
8711	Machine and carpenter shop	27,33
8801	General office	1,39
8803	Warehouse	13,66
8819	Laboratory	6,1
8840	Sample room	2,8
8901	Miscellaneous accounts	37,1
8999	Indirect expense	140,2
9000	Power plant	434,7
9001	Oil supply sump and pump house	40,6
	Total cost	$2,105,0

CHAPTER II

COMPARATIVE COSTS

Plain Concrete

Number	Name of Account	Labor Cost: Cu Yd	Labor Cost: Amount	Labor Cost: Per Cu Yd	Material Cost: Amount	Material Cost: Per Cu Yd	Total C: Amount
7308 1	Trestle approach to trestle	2519	$729 18	$2 90	$1,152 42	$4 57	$1,890 60
7309 1	Track scales, receiving yard	186 0	545 02	2 91	1 146 87	6 17	1,692 49
7310	Bridge No 1	319 8	1 028 20	3 01	1 968 18	6 82	2,996 64
7312 1	Retaining wall	203 5	512 14	2 52	734 25	3 61	1,246 59
7313 1	Calcine track scales	41 6	207 55	4 99	193 60	4 65	401 15
7314 1	Approach to receiving bins	754 3	2 409 16	3 19	3 017 05	4 00	5,426 11
7402	Receiving bins	611 3	1 235 51	2 02	2,247 70	3 67	3,483 21
7802	Sampling plant	120 2	665 91	5 03	649 44	5 38	1,255 35
8102	Roaster plant	250 5	765 42	3 06	1,060 63	4 27	1,835 05
8122	Roaster dust chamber	472 9	1 040 71	2 22	1,775 05	3 75	2,824 76
8306 1	Flues from boilers to reverb flue	9 2	74 22	8 07	74 02	8 01	148 24
8404 1	Converter stands	173 9	555 53	3 19	1 331 03	7 66	1,886 56
8419 2	Bullion scales	10 5	58 32	5 55	65 19	6 21	123 51
8422	Converter dust chamber	296 4	664 85	2 24	1 239 17	4 18	1,903 02
8426 20	Well pan	7 5	53 80	7 19	55 96	7 46	109 26
8602	Flumes	872 7	658 42	0 75	4 199 65	4 81	4,854 07
8622	Converter flue	142 0	165 79	1 17	652 60	4 59	818 42
8627	Roaster dust chamber flue	114 6	224 35	1 96	551 23	4 81	775 58
8703	Boiler and blacksmith shop	78 7	456 57	5 79	544 49	7 42	1,001 06
8710	Machine and carpenter shop	195 5	792 05	7 51	584 06	5 53	1,376 11
8811	Warehouse	139 0	478 16	7 44	956 79	6 96	1,734 35
8813	Sample room	9 3	61 80	6 70	63 63	7 16	125 43
8901	Investiche and some equipment	53 8	166 18	3 13	186 08	3 42	352 26

Plain Concrete (*Continued.*)

Number	Name of Account	Cu. Yd.	Labor Cost Amount	Labor Cost per Cu. Yd.	Material Cost Amount	Material Cost per Cu. Yd.	Total Cost Amount	Total Cost per Cu. Yd.
8906.01	Water pipe lines, etc.	2.3	17.37	7.55	17.85	7.76	35.23	15.31
8908.2	Power conduits	27.6	198.14	7.18	217.15	7.87	415.29	15.04
8908.5	Power conduit branches	5.0	25.36	5.07	30.63	6.12	55.99	11.19
8916	Temporary power plant	14.4	56.04	3.89	98.69	6.86	154.73	10.75
8917	" crushing plant	101.1	303.15	3.00	534.13	5.28	837.28	8.28
8918	" oil and water tanks	48.8	149.27	3.06	263.01	5 39	412.28	8.45
9002	Power plant	231.7	$1,699.92	$7.34	$1,460.02	$6.30	$3,159.94	$13.64
9002.3	" drain	34.6	205.68	5.94	227.37	6.57	433.05	12.52
9006.01	" Nordberg engines	686.3	774.06	1.13	3,020.83	4.40	3,794.89	5.53
9007.01	" turbines	196.5	959.08	4.88	1,432.70	7.29	2,391.28	12.16
9008.01	" condensers	50.3	291.08	5.79	285.18	5.67	576.26	11.45
9009.01	" jet condenser	16.5	66.27	4.02	69.99	4.24	136.26	8.26
9009.21	" 2 air pumps	210.0	560.04	2.67	708.93	3.37	1,268.97	6.04
9010.01	" air compressor	238.3	840.98	3.53	1,246.54	5.23	2,087.52	8.76
9011.01	" exciters, etc.	373.0	1,439.67	3.86	1,875.43	5.03	3,315.10	8.89
9012.01	" motor generators	107.0	296.52	2.77	658.91	6.16	955.43	8.93
9014.01	North and south steam mains	194.5	578.24	2.97	945.97	4.86	1,524.21	7.84
9015.2	Power plant exhaust pipe	18.3	63.09	3.45	102.81	5.62	165.90	9.07
	Total	7,779.4	$22,391.30	$2.85	$37,593.53	$4.82	$59,984.83	$7.67

Miscellaneous Concrete

Number	Name of Account	Cu. Yd.	Labor Cost Amount	Labor Cost per Cu. Yd.	Material Cost Amount	Material Cost per Cu. Yd.	Total Cost Amount	Total Cost per Cu. Yd.
7702	Crusher plant	220.5	$893.15	$4.05	$1,568.47	$7.11	$2,461.62	$11..16
7902	Bedding plant	2,809.7	6,256.34	2.23	14,513.21	5.16	20,769.55	7.39
8302	Reverberatory plant	2,810.0	7,715.96	2.74	15,044.09	5.35	22,760.05	8.10
8307.11	Waste heat boilers	138.7	789.52	5.69	793.97	5.72	1,583.49	11.42
8307.12	Oil-fired boilers	100.0	350.45	3.50	686.29	6.86	1,036.74	10.37
8307.13	Feed pumps	214.7	678.73	3.16	1,428.97	6.66	2,107.70	9.82
8402	Converter plant	776.9	1,796.56	2.31	2,860.16	3.68	4,656.72	6.00
8414	Casting machines	291.9	1,627.37	5.58	1,889.36	6.47	3,516.73	12.05
8502	Conveying system	622.3	2,550.78	4.10	4,006.37	6.44	6,557.15	10.54
8821	Laboratory	96.5	448.42	4.65	575.13	5.96	1,023.55	10.61
8902.2	Sewer system	53.8	168.18	3.13	184.08	3.42	352.26	6.55
9013	Transfer table pit	12.0	24.13	2.01	58.23	4.85	82.36	6.86
9017.01	Feed water heating plant	105.4	708.06	6.72	551.04	5.23	1,259.10	11.95
9017.21	Condensed water pump house	171.0	1,171.89	6.85	854.68	5.00	2,026.57	11.85
9060.21	Supply tanks, reverbs. and oil-fired boilers	189.5	875.70	4.62	1,685.76	8.90	2,561.46	13.52
	Total	8,706.1	$26,055.24	$2.99	$46,699.81	$5.36	$72,755.05	$8.36

Reinforced Concrete

Number	Name of Account	Cu. Yd.	Labor Cost Amount	Labor Cost per Cu. Yd.	Material Cost Amount	Material Cost per Cu. Yd.	Total Cost Amount	Total Cost per Cu. Yd.
8307.10	Reverb. boiler bldg.	573.7	$2,181.08	$3 80	$3,846 18	$6 70	$6,027 26	$10 5
8612	Reverberatory flue.	487.8	1,657 09	3 40	3,886 80	7 97	5,543 89	11.3
9002.1	Power house.....	508.5	3,735 78	7 35	3,628 81	7.14	7,364 59	14.4
.2	North tunnel.....	180.3	1,350 79	7 49	1,230 57	6 83	2,581.36	14.3
9051	Cooling tower.....	706.3	5,212 31	7 38	5,640 13	7 99	10,852 44	15.3
9060.01	Oil supply sump and pump house.	340.6	2,338.72	6 87	3,230 46	9 48	5,569.18	16.3
.12	Oil storage tanks..	32.8	128 70	3 92	210 61	6 42	339 31	10.3
	Total.....	2,830.0	$16,604 47	$5 87	$21,073 56	$7 66	$38,278 03	$13.5
	Total concrete foundations.....	19,315.5	$65,051 01	$3 37	$105,966 90	$5 48	$171,017 91	$8.8

Plain Concrete Floors

Number	Name of Account	Sq. Ft.	Thickness	Labor Cost Amount	Labor Cost per Sq. Ft.	Material Cost Amount	Material Cost per Sq. Ft.	Total Cost Amount	Total Cost per Sq. Ft.
7802.1	Sampling plant, ground floor.....	1,222	5 in.	$105 68	$0 086	$26 02	$0 21	$131 60	$0.1
8307.3	Around boilers.....	2,705	4 "	270 29	0 10	661 82	0 25	941 11	0.3
8812.41	Warehouse floor and platform....	8,298	4 "	558 01	0 067	771 60	0 093	1,329 61	0.1
8821.1	Laboratory.....	1,026	4 "	114 78	0 11	154 00	0 15	268 68	0.2
8842.1	Sample room.....	489	5 "	64 17	0 13	75 25	0 15	139 42	0.2
9002.4	Power plant basement.....	12,130	5 "	916 41	0 07	1,317 78	0 11	2,234 19	0.1
9017.22	Condensed water pump house.....	355	4 "	78 41	0 22	57 70	0 16	136 11	0.3
		26,225		$2,111 78	$0 08	$3,285 97	$0 11	$5,397 75	$0.2
	The above concrete floors were laid in small blocks 5 to 6 ft. square, having a bushed t and with sand joints between all squares								
8416.11	Loading platform..	6,803	5 in	381 02	0 06	1,060 55	0 15	1,441 57	0.2
	The floor above was finished as a large slab with no sand joints								

Reinforced Concrete Floors

Number	Name of Account	Sq. Ft.	Thickness	Labor Cost Amount	Labor Cost per Sq. Ft.	Material Cost Amount	Material Cost per Sq. Ft.	Total Cost Amount	Total Cost per Sq. Ft.
7802.2	Sampling plant....	4,244	4½ in.	$1,050 01	$0 25	$1,090 90	$0 25	$2,140 91	$0.5
8307.2	Over slag track cut	7,676	5 "	1,018 17	0 13	1,287 29	0 22	2,305 46	0.3
8821.1	Laboratory.....	364	4½ "	59 81	0 16	114 87	0 32	174 68	0.4
9017.015	Feed water heating plant.....	1,330	4½ "	292 49	0 21	272 51	0 21	565 97	0.4
		13,614		$2,411 05	$0 18	$3,155 97	$0 24	$5,567 02	$0.4
	The floors above were formed, reinforced and bushed								
9003.41	Power plant main floor.....	10,210	3½ in	1,207 91	0 12	1,781 61	0 17	2,989 52	0.2
	The floor above was laid on Herget plate steel and bushed								
9051.02	Power plant cooling tower.....	17,116	4 in	911 91	0 05	1,385 01	0 08	2,296 92	0.1
	The floor above was reinforced, laid on the ground and straight edged with no finish								

Coping

Number	Name of Account	Lin. Ft.	Labor Cost Amount	Labor Cost per Ft.	Material Cost Amount	Material Cost per Ft.	Total Cost Amount	Total Cost per Ft.
8703.22	Boiler and blacksmith shop....	200	$112.17	$0.38	$2.72	$0.01	$114.89	$0.40
8717.22	Machine and carpenter shop...	320	121.67	0.37	23.70	0.08	145.37	0.45
8812.22	Warehouse.....	320	176.60	0.55	36.53	0.12	213.13	0.67
9017.243	Condensed water pump house..	57	14.50	0.25	2.73	0.04	17.23	0.30
		987	$424.94	$0.43	$65.68	$0.07	$490.62	$0.50
	This coping was 12 in. deep, projecting 2 in. from tile work							
9003.12	Power house.....	732	$372.69	$0.51	$107.05	$0.15	$479.74	$0.66
	This coping was 18 in. deep, projecting 2 in. from tile work							

Excavation—Type No. 1

This class covers shallow excavation made with picks, shovels, wheelbarrow and slips. The haul is less than 100 ft.

Number	Name of Account	Total Cost.	Cu. Yd.	Cost per Cu. Yd.
7308	Trestle approach to reverb. bldg.....	$359.95	277	$1.30
7313	Track scales on calcine track.....	108.95	118	0.92
7314	Trestles to receiving bins.....	548.18	589	0.93
7801	Sampling plant.....	295.06	332	0.89
8410	Air pipe line from power house.....	224.06	331	0.68
8416	Loading platform.....	212.77	216	0.99
8419.1	Bullion scales.....	19.76	24	0.82
8501	Conveying system.....	1,824.22	2,286	0.80
8611	Reverberatory flue.....	936.93	1,588	0.59
8621	Converter flue.....	168.02	198	0.85
8626	Roaster dust chamber flue.....	225.37	213	1.06
8812.4	Warehouse, floor.....	129.03	66	1.96
8820	Laboratory.....	191.27	212	0.90
8841	Sample room.....	61.35	72	0.85
8902.1	Sewer system.....	2,188.04	2,808	0.78
8906	Water pipe lines, tanks, etc.....	868.11	1,078	0.81
8908	Power conduit.....	358.53	435	0.82
8908	Power conduit branches.....	49.20	53	0.93
8909	Permanent air lines.....	267.50	401	0.67
8922	Temporary pipe lines.....	169.13	148	1.14
8923	Temporary warehouse.....	47.29	87	0.54
9009	Jet condenser not well.....	29.72	46	0.65
9014	North and south steam mains.....	249.65	279	0.89
9015.22	Exhaust pipe.....	20.82	29	0.72
9017.20	Condensed water pump house.....	229.49	236	0.97
9060.40	Oil piping.....	992.12	1,150	0.86
	Total.....	$10,774.52	13,272	$0.81

Excavation—Type No. 2

This class covers excavation made with picks, shovels, slips and carts. The haul is over 100 ft. in every case.

Number	Name of Account	Total Cost	Cu. Yd.	Cost per Cu. Yd.
7309	Track scales in receiving yard	$348.91	388	$0.90
7312	Retaining walls	77.66	60	1.29
7701	Crushing plant	689.67	609	1.13
8306	Flues from boilers to reverbs	19.86	15	1.32
8307.01	Waste heat boilers	213.44	129	1.65
8307.03	Feed pumps	601.44	659	0.91
8404	Converter stands	258.88	304	0.85
8413	Two casting machines	520.82	512	1.02
8421	Converter dust chamber	127.28	265	0.48
8426.1	Wet pan	2.44	3	0.81
9017	Feed water heating plant	241.09	274	0.88
9050	Cooling tower	1,674.32	1,589	1.05
9060	Oil supply sump and pump house	1,257.02	1,308	0.96
9060.11	Storage tanks	308.20	554	0.56
	Total	$6,341.03	6,669	$0.95

Excavation—Type No. 3

This class covers excavation made with powder, picks, shovels and wheelbarrows. The haul was less than 100 ft.

Number	Name of Account	Total Cost	Cu. Yd.	Cost per Cu. Yd
8906.2	Water supply tank	$143.68	116	$1.24
8916	Temporary power plant	354.07	388	0.91
8917	Temporary crushing plant	57.00	156	0.37
8920	Wagon road	924.74	951	0.97
9005	Well grading	2,075.75	2,600	0.80
	Total	$3,555.24	4,211	$0.84

Excavation—Type No. 4

This class covers excavation made with powder, picks, shovels, slips, fresnos and carts. The haul was over 100 ft.

Number	Name of Account	Total Cost	Cu. Yd.	Cost per Cu. Yd.
7901	Bedding plant	$12,259.43	12,319	$0.99
8101	Roaster plant	1,547.07	1,216	1.27
8307	Reverb. boiler building	283.14	306	0.93
8312.10	Feed piping from heating plant to pumps	1,091.42	1,296	0.84
9060.20	Supply tank for reverbs. and boilers	405.31	404	1.00
	Total	$15,586.37	15,541	$1.00

Excavation Type No. 5

This class covers excavation done with plows, slips, fresnos, and in some cases powder. The haul was less than 100 ft.

Number	Name of Account	Total Cost	Cu. Yd.	Cost per Cu. Yd.
8701	Boiler and blacksmith shop	$1,186.88	1,458	$0.82
9001	Power house	7,796.65	7,313	1.07
9060.14	Railroad grading at oil sump	1,477.27	2,439	0.61
	Total	$10,460.80	11,210	$0.93

Excavation—Type No. 6

This class covers excavation made with plows, slips, fresnos, and in some cases powder. The haul was over 100 ft.

Number	Name of Account	Total Cost	Cu. Yd.	Cost per Cu. Yd.
8121	Roaster dust chamber	$1,112.83	1,194	$0.93
8301	Reverberatory plant	1,477.66	1,890	0.78
8307.02	Oil-fired boilers	73.60	97	0.76
8401	Converter plant	5,731.11	6,330	0.91
8601	Chimney	367.05	597	0.61
8715	Machine shop	1,941.11	1,765	1.10
8810	Warehouse	996.08	1,287	0.77
	Total	$11,699.44	13,160	$0.89

Excavation—Type No. 7

These are miscellaneous jobs where a variety of methods were used.

Number	Name of Account	Total Cost	Cu. Yd.	Cost per Cu. Yd.
7301	Yard tracks and industrial system	$35,566.00	55,405	$0.64
8901	Derricks and construction equip	30.32	41	0.74
8905.01	Permanent outside lighting	17.87	21	0.85
8952	Employes quarters	401.63	318	1.26
8961	Steam heating installation	166.36	228	0.73
9016	Power house water pipe	1,485.34	2,406	0.62
9017.1	Feed water heating plant	157.19	266	0.59
	Total	$37,824.71	58,685	$0.64

Excavation—Type No. 8

This class covers excavation made with picks, shovels, wheelbarrows and carts. A large portion of it was windlassed from deep pits.

Number	Name of Account	Total Cost	Cu. Yd.	Cost per Cu. Yd.
7401	Receiving bins	$2,342.27	1,428	$1.64

Excavation—Type No. 9

This covers backfilling and tamping in 4 to 5-in. layers.

Number	Name of Account	Total Cost	Cu. Yd.	Cost per Cu. Yd.
8301.01	Reverberatory plant	$2,755.55	3,679	$0.75
8307.04	Reverb. boiler building	548.10	972	0.56
8416.2	Loading platform	67.85	129	0.53
9050.01	Cooling tower	1,395.20	2,415	0.58
	Total	$4,766.70	7,195	$0.66
	Total excavation	$103,351.08	131,371	$0.79

Lighting

Number	Name of Account	No. Drops	Labor Cost Amount	Labor Cost per Drop	Material Cost Amount	Material Cost per Drop	Total Cost Amount	Total Cost per Drop
7407	Receiving bins	22	$60.87	$2.77	$24.67	$1.12	$85.54	$3.89
7707.1	Crushing plant	8	76.41	9.55	38.22	4.78	114.63	14.33
7806.1	Sampling plant	36	178.80	4.97	146.22	4.06	325.02	9.03
7906	Bedding plant	63	306.85	4.87	127.38	2.02	434.23	6.89
8109	Roaster plant	67	340.64	5.09	157.70	2.35	498.34	7.44
8313.1	Reverb. and boiler bldg.	104	612.30	5.89	473.19	4.55	1,085.49	10.44
8409.1	Converter plant	60	451.93	7.53	462.01	7.70	913.94	15.23
8506	Conveying system	33	189.86	5.76	84.56	2.56	274.42	8.32
8708	Boiler and blacksmith shop	17	23.41	1.38	44.50	2.62	67.91	4.00
8722	Machine shop	20	55.84	2.79	135.01	6.75	190.85	9.54
8812.50	Warehouse	26	45.09	1.73	70.48	2.71	115.57	4.45
8846	Sample room	7	22.97	3.28	52.83	7.54	75.80	10.82
9017.12	Feed water heating plant	6	53.35	8.89	25.83	4.31	79.18	13.20
9019	Power house	94	307.86	3.28	1,449.97	15.42	1,757.83	18.70
	Total	563	$2,726.18	$4.84	$3,292.57	$5.85	$6,018.75	$10.69

Cost and Erection of Machinery

Number	Name of Account	Cwt.	Labor Cost Amount	Labor Cost per Cwt.	Erection Cost Amount	Erection Cost per Cwt.	Total Cost Amount	Total Cost per Cwt.
	Group No. 1							
8313–8317	Two electrical feed pumps	433.45	$375.70	$0.87	$375.70	$0.87	$6,187.56	$14.28
8316	Six No. 14 Wilgus oil systems	84.75	111.48	1.32	123.82	1.46	1,973.77	23.29
8317.1	Two steam feed pumps	35.47	37.27	1.05	38.12	1.07	499.24	14.07
9006.1	Two Nordberg blowers with air receivers	3,832.42	1,641.62	0.43	3,080.52	0.80	34,155.64	8.91
9007.1	Three Curtis turbines and ten auto transformers	4,541.40	2,297.70	0.51	4,442.20	0.98	81,884.19	18.03
9009.12	Two dry vacuum pumps for jet condenser	242.00	285.51	1.18	517.38	2,14	3,145.52	13.00
9009.22	Two circulating pumps	375.60	366.90	0.98	433.78	1.15	3,902.58	10.39
9010.02	Air compressor	978.40	642.90	0.66	791.57	0.81	.....	.....
9011.03	Three dry vacuum pumps	140.00	147.26	1.05	196.78	1.42	3,337.36	23.84
9011.04	Three pumps and engines	972.55	389.32	0.40	568.75	0.58	9,118.69	9.38
9060.02	Two 5 by 8 vertical triplex pumps	113.54	176.20	1.55	195.07	1.72	2,211.78	19.48
		11,749.58	$6,471.86	$0.55	$10,763.69	$0.92	$146,416.33	$13.59

Group No. 2

Number	Name of Account	Cwt.	Labor Cost Amount	Labor Cost per Cwt.	Erection Cost Amount	Erection Cost per Cwt.	Total Cost Amount	Total Cost per Cwt.
8406	Two 40-ton Morgan cranes	2,215.00	$1,438.50	$0.65	$3,813.34	$1.72	$23,027.65	$10.40
8407	Two clinkering machines	1,692.13	1,715.23	1.01	2,435.73	1.44	15,697.17	9.28
8415	Two casting machines.	2,692.20	3,266.34	1.21	3,682.40	1.37	27,477.55	10.21
		6,599.33	$6,420.07	$0.97	$9,931.47	$1.50	$66,202.37	$10.03

Group No. 3

7704	Farrell crusher, 36 by 18	500.00	392.86	0.79	401.31	0.80	1,486.47	2.96
8112	Two motor-driven fans at roaster building	61.40	77.69	1.27	81.11	1.32	1,483.60	24.16
8718	Traveling hand crane, 5 ton	30.00	25.19	0.84	44.90	1.50	589.55	19.65
9004	" 20 ton	252.00	131.89	0.52	169.16	0.67	1,855.16	7.36
9008.1	Three surface condensers	1,157.00	415.31	0.36	542.82	0.47	19,978.86	17.27
9009.03	One barometric condenser	81.32	128.97	1.59	185.33	2.28	1,078.65	13.26
		2,081.72	$1,171.91	$0.56	$1,424.63	$0.68	$26,472.29	$12.72

Group No. 4

9011.02	Two exciters	543.00	491.01	0.90	864.31	1.59	6,609.27	12.17
9012.02	Two 150 Kw. synchronous generator sets	418.98	319.06	0.76	699.23	1.67	7,149.39	17.09
		961.98	$810.07	$0.84	$1,563.54	$1.63	$13,758.66	$14.30

In the above average costs an effort has been made for a logical grouping, yet it is somewhat arbitrary. Group 1 contains the erection of engine machinery. It was here necessary, in addition to handling heavy weights and placing on the foundation, to clean, adjust, and line up many mechanical parts. Group 2 is very similar to 1, but the machinery is not of the engine type and not so heavy in proportion to the labor required to put it in working order. Group 3 composes machinery that required little other labor in the main than the lifting of heavy loads into place. Group 4 is somewhat similar to Group 3, but the labor is principally electrical. The above costs are reported as labor, erection, and total costs. The labor cost is self explanatory. The erection cost is the labor cost plus the needed small supplies, such as waste, oil, small tools, and the like. The total cost is also self-explanatory.

Masonry

Number	Name of Account	Cu. Yd.	Labor Cost Amount	Labor Cost per Cu. Yd.	Material Cost Amount	Material Cost per Cu. Yd.	Total Cost Amount	Total Cost per Cu. Yd.
7312.2	Retaining wall	21.9	$88.08	$4.03	$47.51	$2.17	$135.59	$6.19

Cost of Painting Concrete

Number	Name of Account	Sq. Yd.	Labor Cost Amount	Labor Cost per Sq. Yd.	Material Cost Amount	Material Cost per Sq. Yd.	Total Cost Amount	Total Cost per Sq. Yd.
9002.45	Power house basement floor. Two coats of Toch cement filler	830	$81.45	$0.10	$48.81	$0.06	$130.26	$0.16
9002.7	Power house walls and foundations. One coat of Wadsworth Howland Bay State cement paint	2,459	195.84	0.08	301.61	0.12	497.45	0.20
9003.43	Power house, top of main floor slab. Two coats of Toch cement filler—one coat of Toch cement paint	1,134	95.56	0.08	199.32	0.18	294.88	0.26

Painting Corrugated Iron

Number	Name of Account	Sq. Yd.	Labor Cost Amount	Labor Cost per Sq. Yd.	Material Cost Amount	Material Cost per Sq. Yd.	Total Cost Amount	Total Cost per Sq. Yd.
8812.30	Warehouse roof, underside...	813	$81.16	$0.10	$65.66	$0.08	$146.82	$0.18
	Two coats white lead and oil							

Painting Berger Plate

9003.42	Power house main floor slab, underside.....	2,679	181.88	0.07	147.58	0.06	329.46	0.12
.54	Power house roof, underside..	6,813	692.84	0.10	324.55	0.05	1,017.39	0.15
	Two coats white lead and oil							

Square yards derived by developing the Berger plate. This is three times the superficial area

Miscellaneous Painting

Number	Name of Account	Sq. Yd.	Labor Cost Amount	Labor Cost per Sq. Yd.	Material Cost Amount	Material Cost per Sq. Yd.	Total Cost Amount	Total Cost per Sq. Yd.
8703.60	Boiler shop.....	1,574	$92.53	$0.05	$60.73	$0.04	$153.26	$0.10
8718.60	Machine shop.....	1,989	118.00	0.06	87.40	0.04	205.40	0.10
8813.10	Warehouse.....	412	26.50	0.06	14.17	0.03	40.67	0.10
		3,975	$237.03	$0.06	$162.30	$0.04	$399.33	$0.10

This was two-coat work on wood

Painting Window Sash and Doors

Number	Name of Account	No. of Sash	Labor Cost Amount	Labor Cost per Sash	Material Cost Amount	Material Cost per Sash	Total Cost Amount	Total Cost per Sash
7803.11	Sampling plant.....	129	$118.94	$0.92	$28.96	$0.22	$147.90	$1.14
8813.11	Warehouse.....	189	122.78	0.65	15.34	0.08	138.12	0.73
	Window sash and frames, two-coat work							
9003.60	Power house.....	299	290.09	0.97	16.72	0.05	306.81	1.02
	Window sash only, three-coat work							
	Doors figured as two sash							

Roofs

Number	Name of Account	Squares	Labor Cost Amount	Labor Cost per Sq.	Material Cost Amount	Material Cost per Sq.	Total Cost Amount	Total Cost per Sq
8703.30	Boiler and blacksmith shop.....	66.49	$286.52	$4.31	$828.24	$12.46	$1,114.76	$16.77
8717.30	Machine and carpenter shop.....	77.21	297.85	3.86	953.04	12.34	1,250.89	16.20
		143.70	$584.37	$4.06	$1,781.28	$12.40	$2,365.65	$16.46
	Consists of 2 by 8 tongue and groove sheathing, asbestos roofing and nailing strips. No painting included							
8843.4	Sample room.....	8.0	$23.00	$2.88	$76.57	$9.57	$99.57	$12.45
	Consists of 1 by 12 sheathing and asbestos roofing. No painting included							
9003.5	Power house.....	214.83	$3,587.15	$16.70	$5,791.05	$26.96	$9,378.20	$43.65
	Consists of Berger plate, concrete, tar, and P and B roofing. Painting the underside of the Berger plate is included							
9017.04	Feed water heating plant	8.80	$115.25	$13.10	109.88	$12.48	$225.13	$25.58
9017.25	Condensed water pump house.....	5.00	73.92	14.78	60.83	12.17	134.75	26.95
		13.80	$189.17	$13.71	$170.71	$12.37	$359.88	$26.08
	Consists of 2 by 8 sheathing with asbestos roofing							
9060.07	Oil pump house.....	6.50	$136.81	$21.05	$162.66	$25.02	$299.47	$46.07
	Consists of "hyrib," concrete and plaster							
9060.131	Oil storage tanks.....	65.56	$761.95	$11.62	$882.84	$13.47	$1,644.79	$25.09
	Consists of wood supporting structure, 1-in. sheathing and metal lath and plaster							

Shafting, Pulleys and Belting

Number	Name of Account	Lin. Ft. of Shafting	Labor Cost Amount	Labor Cost per Ft.	Material Cost Amount	Material Cost per Ft.	Total Cost Amount	Total Cost per Ft.
7804	Sampling plant	85	$64.01	$0.75	$1,871.07	$22.01	$1,935.08	$22.76
8107	Roasting plant	164	118.24	0.72	1,999.89	12.20	2,118.13	12.92
8706	Boiler and blacksmith shop	51	105.59	2.07	301.16	5.91	406.75	7.98
8720	Machine and carpenter shop	162	289.29	1.79	1,513.36	9.34	1,802.65	11.13
8849.2	Sample room	26	23.39	0.89	170.17	6.55	193.56	7.44

Structural Steel

Number	Name of Account	Amount	Tons	Cost per Ton
7308.2	Trestle approach to reverb. building	$13,460.84	163.97	$82.09
7310	Bridge No. 1	377.40	3.70	102.00
7314	Trestles to receiving bins	9,260.48	109.35	84.77
7403	Receiving bins	29,276.63	353.09	82.92
7703	Crushing plant	2,420.36	25.07	96.54
7803	Sampling plant	10,408.12	110.85	93.89
7903	Bedding plant	47,404.86	548.71	86.39
8103	Roasting plant	37,252.67	445.28	83.66
8123	Roaster dust chamber	34,745.41	415.68	83.59
8303	Reverberatory plant	40,709.76	461.09	88.48
8306.2	Flues from boilers to reverb. flue	2,815.32	34.78	80.95
8308	Boiler building	25,839.85	292.03	88.48
8403	Converter plant	69,359.60	783.86	88.48
8423	Converter dust chamber	20,371.20	238.30	85.49
8503	Conveying system	19,365.98	211.73	91.47
8614	Reverberatory flue	3,593.06	41.61	86.35
8624	Converter flue	6,616.44	81.99	80.70
8629	Roaster dust chamber flue	9,209.36	94.46	97.49
8703	Boiler and blacksmith shop	2,913.90	32.72	89.06
8717	Machine and carpenter shop	3,431.42	38.23	89.76
8812	Warehouse	3,734.08	39.76	93.92
9003	Power house	23,773.13	254.29	93.49
9014.02	North and south mains	7,694.58	86.81	88.64
9017.02	Feed water heating plant	2,262.90	26.63	84.98
	Total	$426,396.35	$4,839.99	$87.13

Tile Walls

Number	Name of Account	Cu. Ft.	Labor Cost Amount	Labor Cost per Cu. Ft.	Material Cost Amount	Material Cost per Cu. Ft.	Total Cost Amount	Total Cost per Cu. Ft.
8106.02	Roaster flues	2,305	$374.82	$0.16	$400.36	$0.17	$775.18	$0.33
8123.10	Roaster dust chamber.	14,980	2,268.29	0.15	2,585.45	0.17	4,853.74	0.32
8423.10	Converter dust chamber	6,369	1,620.05	0.25	2,182.40	0.34	3,802.45	0.60
8613	Reverberatory flue	6,400	1,272.86	0.20	1,696.39	0.26	2,969.25	0.46
8628	Roaster dust chamber flue	4,231	1,018.13	0.24	1,573.06	0.37	2,591.19	0.61
8703.20	Boiler and blacksmith shop	2,297	477.95	0.21	612.62	0.27	1,090.57	0.48
8717.20	Machine and carpenter shop	2,307	531.45	0.22	571.28	0.24	1,102.73	0.46
8812.20	Warehouse	2,342	438.00	0.19	477.86	0.20	915.86	0.39
9003.10	Power house	14,343	3,856.83	0.26	4,510.20	0.31	8,367.03	0.58
9017.03	Feed water heating plant	706	285.99	0.41	234.36	0.33	520.35	0.74
9017.242	Condensed water pump house	257	98.87	0.38	84.28	0.33	183.15	0.71
	Total	56,687	$12,243.24	$0.22	$14,928.26	$0.26	$27,171.50	$0.48

Unloading Brick and Tile

Number	Name of Account	Total Cost	Tons	Cost per Ton
8105.01	Roaster brick	$363.14	1,231.01	$0.21
8123.11	Roaster dust chamber tile	307.72	525.05	0.58
8304.01	Reverberatory furnaces	1,264.49	2,279.49	0.55
8305.01	Cross and header flue	497.60	1,329.23	0.37
8309.02	Waste heat boilers	518.91	1,073.74	0.48
8309.12	Oil-fired boilers	183.94	228.11	0.81
8405.11	Converters	186.25	579.30	0.32
8423.11	Converter dust chamber	37.61	155.20	0.24
8613.01	Reverberatory flue	57.79	278.33	0.21
8628.01	Roaster dust chamber flue	57.60	171.40	0.34
8703.21	Boiler and blacksmith shop	18.89	69.70	0.27
8717.21	Machine and carpenter shop	44.06	58.80	0.75
8812.21	Warehouse	16.50	74.20	0.22
9003.11	Power plant	332.57	522.70	0.64
9017.031	Feed water heating plant	24.91	30.00	0.83
	Total	$3,911.98	8,606.26	$0.45

These costs cover such costs as cleaning the site for unloading, building runways where needed, constructing brick sheds, and checking the quantities of the shipment, as well as the unloading of the various shapes in separate piles.

Ventilators

Number	Name of Account	No. of Ventilators	Labor Cost Amount	Labor Cost per Vent	Material Cost Amount	Material Cost per Vent	Total Cost Amount	Total Cost per Vent
8703.31	Boiler and blacksmith shop	3	$16.01	$5.33	$261.50	$87.17	$277.51	$92.50
8717.31	Machine and carpenter shop	3	11.16	3.72	248.24	82.74	259.40	86.46
		6	$27.17	$4.53	$509.74	$84.96	$536.91	$89.49
	48-in. Burt ventilators, square base, set on wooden roof							
8812.31	Warehouse	3	$30.38	$10.13	$207.12	$69.04	$237.50	$79.17
	48-in. Burt ventilators, round base, set on corrugated iron roof							
9003.3	Power house	6	$125.60	$20.94	$439.76	$73.29	$565.36	$94.23
	48-in. Burt ventilators, square base, set on concrete roof							
9017.045	Feed water heating plant	2	$142.14	$71.07	$49.20	$24.60	$191.34	$95.67
	42-in. ventilators made in new smelter shops, set on wooden roof							

Windows and Doors

Number	Name of Account	Sq. Ft. Opening	Labor Cost Amount	Labor Cost per Sq. Ft.	Material Cost Amount	Material Cost per Sq. Ft.	Total Cost Amount	Total Cost per Sq. Ft.
7703.1	Crushing plant	529	$84.00	$0.16	$170.71	$0.32	$254.71	$0.48
7803.1	Sampling plant	2,086	332.94	0.16	564.90	0.27	897.84	0.43
		2,615	$416.94	$0.16	$735.61	$0.26	$1,152.55	$0.44
	The above accounts cover wooden sash and frame set in steel and corrugated iron building							
8843.5	Sample room	298	$32.39	$0.11	$118.85	$0.40	$151.24	$0.51
	The above account covers wooden sash and frame set in wood and corrugated iron building							
8703.1	Boiler and blacksmith shop	2,581	$693.02	$0.27	$2,456.28	$0.95	$3,149.30	$1.22
8717.1	Machine and carpenter shop	3,037	923.61	0.30	2,992.16	0.99	3,915.77	1.29
		5,618	$1,616.63	$0.29	$5,448.44	0.97	$7,065.07	$1.26
	The above accounts cover steel sash and frame set in steel and tile curtain wall building							

Windows and Doors (*Continued*)

Number	Name of Account	Sq. Ft. Opening	Labor Cost Amount	Labor Cost Per Sq. Ft.	Material Cost Amount	Material Cost Per Sq. Ft.	Total Cost Amount	Total Cost Per Sq. Ft.
8812.1	Warehouse	1,982	$533.02	$0.27	$1,056.31	$0.53	$1,589.33	$0.80
8822.5	Laboratory	823	208.70	0.25	480.33	0.59	689.03	0.81
9017.035	Heater house	186	59.83	0.32	99.98	0.54	159.81	0.86
9017.24	Cond. water pump house.	57	26.02	0.45	22.68	0.40	48.70	0.85
		3,048	$827.57	$0.27	$1,659.30	$0.54	$2,486.87	$0.81
	The above account covers wooden sash and frame set in steel and tile curtain wall building							
9060.06	Oil pump house	124	$83.60	$0.68	$65.02	$0.52	$148.62	$1.20
	The above account covers wooden sash and frame set in concrete walls							
9003.2	Power house	4,044	$974.38	$0.24	$3,319.93	$0.82	$4,294.31	$1.06
	The above account covers steel frame and wooden sash set in steel and tile curtain wall building							

Wire Baffles

Number	Name of Account	C. Wires	Labor Cost Amount	Labor Cost per C. Wires	Material Cost Amount	Material Cost per C. Wires	Total Cost Amount	Total Cost per C. Wires
8123.01	Roaster dust chamber	604.80	$523.63	$0.87	$1,758.23	$7.87	$5,281.86	$8.73
8423.01	Converter dust chamber	166.10	138.86	0.84	1,101.95	6.63	1,240.81	7.47
		770.90	$662.49	$0.86	$5,860.18	$7.66	$6,522.67	$8.46

Woodwork

Number	Name of Account	M.B.M.	Labor Cost Amount	Labor Cost per M.B.M.	Material Cost Amount	Material Cost per M.B.M.	Total Cost Amount	Total Cost per M.B.M.
7308.3	Trestle approach to reverb. bldg.	27.65	$703.93	$25.45	$768.92	$27.81	$1,472.85	$53.27
7314.3	Trestle to receiving bins	27.21	572.23	21.03	838.11	30.80	1,410.34	51.83
		54.86	$1,276.16	$23.26	$1,607.03	$29.29	$2,883.19	$52.55
9052	Cooling tower	128 63	3,181.33	24.73	5,415.47	42.10	8,596.80	66.84
9060.16	Track bumpers	3.16	246.74	78.08	47.92	15 16	294.66	93.25

Wooden Floors

Number	Name of Account	Sq. Ft.	Labor Cost Amount	Labor Cost per Sq. Ft.	Material Cost Amount	Material Cost per Sq. Ft.	Total Cost Amount	Total Cost per Sq. Ft.
8717.40	Machine and carpenter shop. See sketch No. 24	4,136	$269.80	$0.07	$593.30	$0.14	$863.10	$0.21

CHAPTER III

COMPOSITE COSTS

Cost of Building per Square Foot of Floor Space

Number	Name of Account	Sq. Ft. of Floor Space	Total Cost Amount	Total Cost Per Sq. Ft.
7700	Crushing plant	1,650	$5,968.32	$3.62
	Includes accounts 7701 to 7703.2 inclusive and 7707.1			
7800	Sampling plant	6,140	16,299.16	2.65
	Includes accounts 7801 to 7803.11 inclusive, 7806.1 and 7809			
8100	Roasting plant	28,740	43,322.75	1.51
	Includes accounts 8101 to 8103.1 inclusive, and 8109			
8300	Reverberatory plant	20,370	50,687.28	2.49
	Includes accounts 8301 ($784 32,) 8302 ($8,560.45), 8303 and one-half of 8313.1			
8307	Reverberatory boiler building	14,310	36,887.67	2.58
	Includes accounts 8307; 0.04; 0.1; 0.2; 0.3; 8308, one-half of 8313.1			
8400	Converter building	26,084	87,231.14	3.34
	Includes accounts 8401, 8402, 8403, 8409.1, 8413, 8414, 8416, 8416.1, 8416.11 and 8416.2			
8700	Boiler and blacksmith shop	4,424	11,320.58	2.56
	Includes accounts 8701 to 8703.40 inclusive, 8703.60 and 8708			
8714	Machine and carpenter shop	5,144	14,905.56	2.90
	Includes accounts 8714 to 8717.50 inclusive; 8717.60 and 8722			
8809	Warehouse	5,040	11,512.93	2.28
	Includes accounts 8810 to 8812.50 inclusive; 8813.10 and 8813.11			
8819	Laboratory	1,492	11,363.77	2.92
	Includes accounts 8820 to 8822.5 inclusive; 8825, 8828 and 8829			
8840	Sample room	600	991.46	1.65
	Includes accounts 8841 to 8843.5 inclusive; 8846 and 8848			
9000	Power plant	32,096	77,452.56	2.41
	Includes accounts 9001 to 9003.61 inclusive, excluding 9002.2			

Cost of Buildings per Cubic Foot

Number	Name of Account	Cu. Ft. in Building	Total Cost Amount	Total Cost Per Cu. Ft.
7700	Crushing plant	27,040	$5,968.32	$0.22
7800	Sampling plant	80,547	16,299.16	0.20
8100	Roasting plant	410,140	43,322.75	0.11
8300	Reverberatory plant	474,350	50,687.28	0.11
8307	Reverberatory boiler building	500,850	36,887.67	0.07
8400	Converter building	1,529,636	87,231.14	0.06
8700	Boiler and blacksmith shop	86,268	11,320.58	0.15
8714	Machine and carpenter shop	100,308	14,905.56	0.15
8809	Warehouse	83,160	11,512.93	0.14
8819	Laboratory	16,140	4,363.77	0.27
8840	Sample room	6,000	991.46	0.16
9000	Power house	784,000	77,452.56	0.10

In the above costs the same account numbers are used as in computing the cost of buildings per square foot of floor space.

Cost of Buildings Equipped Per Square Foot of Floor Space

Number	Name of Account	Sq. Ft. of Floor Space	Total Cost Amount	Total Cost Per Sq. Ft.
7700	Crushing plant	1,650	$9,268.62	$5.62
	Accounts 7701 to 7707.1 inclusive			
7800	Sampling plant	6,140	34,108.74	5.56
	Accounts 7801 to 7810 inclusive			
8100	Roasting plant	28,740	136,734.87	4.76
	Accounts 8101 to 8113.2 inclusive			
8300	Reverberatory plant	20,370	172,171.55	8.45
	Accounts 8301 to 8305.2 inc.—8307.2, 8312 and 8313, deducting one-half of each 8314 8315 and 8318—8316, deducting two-thirds of this account			
8307	Reverberatory boiler building	14,310	159,716.26	11.16
	Accounts 8306 to 8317.2 inc. deducting one-half of 8307.2, 8312 and 8313.1, and two-thirds of 8316			
8400	Converter building	26,084	216,033.37	8.28
	Accounts 8401 to 8419.4 and 8425 to 8426.4 inclusive			
8700	Boiler shop	4,424	21,449.23	4.85
	Accounts 8701 to 8708 inclusive			
8714	Machine and carpenter shop	5,144	27,356.27	5.32
	Accounts 8715 to 8722 inclusive			
8809	Warehouse	5,040	13,602.71	2.70
	Accounts 8810 to 8813.11 inclusive			
8819	Laboratory	1,492	6,144.02	4.12
	Accounts 8820 to 8831 inclusive			
8840	Sample room	600	2,826.11	4.71
	Accounts 8841 to 8849.2 inclusive			
9000	Power house	32,096	359,590.10	11.20
	Accounts 9001 to 9004 and 9006.01 to 9016.01 inclusive, deducting one-half of 9014 to 9014.05 inclusive.			

Cost of Buildings Equipped per Cubic Foot.

Number	Name of Account	Sq. Ft. of Floor Space	Total Cost Amount	Total Cost Per Sq. Ft.
7700	Crushing plant	27,040	$9,268.62	$0.34
7800	Sampling plant	80,547	34,108.74	0.42
8100	Roasting plant	410,140	136,734.87	0.33
8300	Reverberatory plant	474,350	172,171.55	0.36
8307	Reverberatory boiler building	500,850	159,716.26	0.32
8400	Converter building	1,529,636	216,033.37	0.14
8700	Boiler and blacksmith shop	86,286	21,449.23	0.24
8714	Machine and carpenter shop	100,308	27,356.27	0.27
8809	Warehouse	83,160	13,602.71	0.16
8819	Laboratory	16,140	6,144.02	0.38
8840	Sample room	6,000	2,826.11	0.47
9000	Power house	784,000	359,590.10	0.46
	The amounts shown above are the same as those used in the cost of buildings equipped per square foot			

Bedding Plant and Bunker Bins. Cost per Cubic Foot of Capacity of both Beds and Bins

Capacity	Total Cost Amount	Total Cost Per Cu. Ft.
228,440 cu. ft.	$150,939.05	$0.66
This cost consists of accounts 7901 to 7908 inclusive		
The capacity was obtained by actual measurement		

Three Spreading Beds. Cost per Cubic Foot of Capacity

Capacity	Total Cost Amount	Total Cost Per Cu. Ft.
160,380 cu. ft.	$120,177.94	$0.75
This is partly as estimated cost. It was obtained by deducting the cost of the bunker bins installation from the total bedding plant, and substituting therefor such excavation, foundation, steel work, etc., as would be necessary to provide for conveyors 7[illegible] and 10[illegible]		

Receiving Bins—Cost per Cubic Foot of Capacity

Capacity	Total Cost Amount	Per Cu. Ft
11,386 cu. ft.	$38,073.73	$3.34

This cost consists of accounts 7401 to 7404 inclusive, and 7407
The capacity of the receiving bins was obtained by assuming that the material lay on a one and one-half to one slope on falling from the cars

Conveyors—Cost per Ton of Capacity

Conveyors	Capacity, Tons per Hour	Total Cost Amount	Per Ton	
No. 1	100	$3,258.11	$32.58	Account 7405
" 2	150	2,853.22	19.02	" 7405.01
" 7^1–7^2	250	6,938.01	27.75	" 7904
" 8^1–8^2–8^3	450	9,929.99	22.07	" 7904.1
" 9^1–9^2–9^3–10^1–10^2	500	11,668.39	23.33	" 7904.2
" 12	100	969.20	9.69	" 8113
" 13^1–13^2	200	3,948.62	19.74	" 8113.1
" 15	100	2,674.24	26.74	" 8425
" 3–4–5–6–11–14	700	13,716.49	19.59	" 8505

The above costs do not include any steel supporting structure for the conveyors. Capacities are taken from the designers' drawings

Complete Conveyor—Cost per Lineal Foot

Conveyor No.	Total Length	Amount	Cost per Foot
No. 3, 4, 5, 6, 11, 14	1,284.9 ft.	$44,290.65	$34.47

Cost consists of accounts 8501 to 8505.2, and 8506. The total length is the sum of the lengths of the various conveyors measured from center of head pulley to center of tail pulley

Cost of Cooling Tower per Thousand Gallons a Minute

M Gallons per Min.	Total Cost Amount	Per M Gallons
12 M	$26,273.01	$2,189.42

Cost consists of accounts 9050 to 9053 inclusive

Cost of Dust Chambers per Cubic Foot

Name	Cu. Ft.	Total Cost Amount	Per Cu. Ft.	
Roaster dust chamber	256,860	$49,664.76	$0.19	Accounts 8121 to 8123.3 inclusive
Converter dust chamber	67,210	27,813.58	0.41	" 8421 to 8428 "

Cost of Flues per Cubic Foot

Name	Cu. Ft.	Total Cost Amount	Per Cu Ft.	
Reverberatory flue	63,420	$13,453.70	$0.21	Accounts 8611 to 8614.2 inclusive
Roaster dust chamber flue	29,527	12,859.10	0.44	" 8625 to 8629 "
Flues from boilers to reverb. flues	6,734	2,983.42	0.44	" 8306 to 8306.2 "
Converter flue	10,705	7,602.88	0.71	" 8621 to 8624 "

Cost of Flues per Lineal Foot

Name	Lin. Ft.	Total Cost Amount	Per Ft.	
Reverb. flue	250	$13,453.70	$53.81	In obtaining these costs the same accounts were used as in computing the cost of flue per cubic foot.
Roaster dust chamber flue	170	12,859.10	75.64	
Flues from boilers to reverb	246	2,983.42	12.13	
Converter flue	208	7,602.88	36.55	

Cost of Power Plant per Indicated Horse Power, Boiler Plant Included

I.H.P.	Total Cost Amount	Per I.H.P.
10,660	$589,717.16	$55.32

Cost consists of accounts 8306 to 8313.1 inclusive—deducting one-half of 8307.2, 8312 and 8313.1 8316 to 8317.2 inclusive—deducting two-thirds of 8316. 9001 to 9004 inclusive. 9006.01 to 9053 inclusive. 9060.20 to 9060.23 inclusive—deducting three-fourths of these accounts.

	I.H.P.
3 turbines	9,160
2 Nordberg blowers	1,000
1 air compressor	200
Total	10,660

Cost of Power Plant per Indicated Horse Power, Boiler Plant not Included

I.H.P.	Total Cost Amount	Per I.H.P.
10,660	$398,631.17	$37.40

Cost consists of accounts 9001 to 9004 inclusive. 9006.01 to 9016.02 inclusive—deducting one-half of 9014 to 9014.05. 9017.20 to 9017.27 inclusive. 9018.1 to 9022 inclusive. 9060 to 9053 inclusive

Cost of Boiler Plant per Boiler Horse Power

Boiler Horse Power	Total Cost Amount	Per Horse Power
6,143	$191,085.99	$31.11

Cost consists of accounts 8306 to 8313.1 inclusive—deducting one-half of 8307.2, 8312 and 8313.1 8316 to 8317.2 inclusive—deducting two-thirds of 8316. 9014 to 9014.05 inclusive—deducting one-half of these accounts. 9017 to 9017.15 inclusive. 9060.20 to 9060.23—deducting three-quarters of these accounts.

Boiler Horse Power

7 waste heat @ 713	4,991
3 oil-fired @ 384	1,152
Total boiler horse power	6,143

Cost of Reverberatory Plant—per Ton of Capacity

Tons per 24 Hr.	Total Cost Amount	Per Ton
1,200	$172,171.55	$143.47

Cost includes accounts 8301 to 8305.2 inclusive. 8307.2, 8312, 8313.1 (one-half of each) 8314, 8315, and 8318. 8316—(two-thirds). 3 reverberatories at 400 tons per 24 hr. capacity

Cost of Complete Roasting Installation per Roaster

No. of Roasters	Total Cost Amount	Per Roaster
8	$136,734.87	$17,091.86

Cost consists of accounts 8101 to 8113.2—Roaster building and roasters

8	$199,258.73	$24,907.34

Cost consists of accounts 8101 to 8113.2 inclusive—Roaster building and roasters. 8121.1 to 8124.3 inclusive—Roaster dust chamber. 8626 to 8629 inclusive—Roaster dust chamber flue

Tracks—Cost per Foot

	Labor Cost		Material Cost		Total Cost	
Length of Track	Amount	Per Foot	Amount	Per Foot	Amount	Per Foot
14,116 ft.	$38,190.18	$2.71	$27,335.46	$1.94	$65,525.64	$4.64

This cost consists of accounts 7301 to 7305 inclusive. The 697 ft. of track which was on trestles was deducted from account 7303.

CHAPTER IV

WAGE SCALE

Occupation	Feb. 28, 1912, Ten Hours		April 1, 1912, Nine Hours		July 24, 1912, Nine Hours		July 1, 1913, Nine Hours		Sept. 1, 1913a, Eight Hour	
	A.	M.	A.	M.	A.	M.	A.	M.	A.	M.
Blacksmiths	.....	$2.50	$4.00	.....	$4.50	.....	$4.50	.....	$4.25	.....
	.....	.....	.....	.....					4.50	.....
" helpers	.....	.....	.....	2.25	3.00	3.00	3.00	3.00	.....	.50
	.....	.....	.....	.....	.....	.....	3.00	3.00	2.50	2.25
	.....	.....	.....	.....	.....	.....	3.50	.....	3.25	3....
Boilermaker boss	.....	.....	.....	.....	.....	.....	5.50	.....	5.50	.....
Boilermakers	.....	.....	.....	.....	4.50	.....	4.50	.....	4.25	.....
" " layer-out	.....	.....	.....	.....	.....	.....	4.75	.....	4.75	..00
" " helpers	.....	.....	.....	.....	3.00	.....	3.00	3.00	3.00	3....
Brick masons	.....	.....	.....	.....	.....	.....	6.50	.....	6.50	...25
" tenders	.....	.....	.....	.....	.....	.....		2.25	.....	2....
Carpenter boss	.....	.....	.....	.....	5.00	.....	5.00	.....	5.00	.....
" 1st class	4.50	.....	4.00	.....	4.50	.....	4.50	.....	4.25	.....
" 2nd class	4.00	4.00	.....	.....	.....	.....	.....	.....	.....	.....
" helpers	3.00	3.00	3.00	3.00	3.00	.....	3.00	.....	2.50	.....
" (with tools)	.....	.....	.....	.....	3.50	.....	3.50	.....	3.00	.....
" helpers	.....	.....	.....	2.25	.....	.....	.....	.....	.....	.....
Cart drivers	.....	.....	.....	.....	2.25	2.25	.....	.....	.....	.....
Cement finisher boss	.....	.....	.....	.....	.....	.....	.....	.....	5.00	.....
" " "	.....	.....	.....	.....	4.50	.....	.....	2.50	.....	.....
	.....	.....	.....	.....	.....	.....	3.50	3.50	.....	.....
	.....	.....	.....	.....	.....	.....	4.00	4.00	.....	.....
Concrete boss	.....	.....	.....	.....	4.50	.....	4.50	.....	.....	.....
" mixers	.....	.....	.....	2.25	.....	2.25	.....	2.25	.....	.....
Corral boss	.....	.....	3.50	.....	3.50	.....	3.50	.....	3.50	.....
" men	.....	.....	.....	.....	2.25	2.25	.....	.....	.....	.....
Drillers	.....	2.25	.....	2.00	.....	.....	.....	.....	.....	.....
Electrician boss	.....	.....	.....	.....	.....	.....	5.00	.....	4.50	.....
	.....	.....	.....	.....	.....	.....	.....	.....	5.00	.....
Electrician	.....	.....	.....	.....	.....	.....	4.50	.....	4.25	.....
" helpers	.....	.....	.....	.....	.....	.....	3.00	2.25	2.75	.....
	.....	.....	.....	.....	.....	.....	.....	.....	3.00	.....
Engineers, locomotive	3.25	.....	.....	.....	.....	.....	.....	.....	.....	.....
" compressors	.....	.....	.....	.....	3.50	.....	3.50	.....	3.50	.....
" stationary	.....	.....	.....	.....	3.00	.....	.....	.....	.....	.....
Janitors	.....	.....	.....	2.00	.....	2.25	.....	.....	.....	.....
Labor bosses	.....	.....	3.25	2.00	4.00	.....	4.00	.....	4.00	.....
	.....	.....	4.00	2.50	.....	.....	4.50	.....	.....	.....
	.....	.....	.....	3.00	.....	.....	.....	.....	.....	.....
Laborers	.....	1.75	.....	1.75	.....	2.00	.....	2.00	.....	1.75
	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.00
Machine shop boss	.....	.....	.....	.....	.....	.....	5.00	.....	5.00	.....
" " " (outside)	.....	.....	.....	.....	.....	.....	5.50	.....	.....	.....
Machinist	.....	.....	4.00	.....	4.50	.....	4.50	.....	4.25	.....
" helpers	.....	.....	3.00	.....	3.00	3.00	3.00	2.50	3.00	3.00
Miners, underground	.....	.....	.....	2.75	.....	2.75	.....	.....	.....	.....
" surface	.....	.....	.....	2.25	.....	2.25	.....	.....	.....	.....
Office boys	.....	.....	.....	.....	.....	.....	.....	2.00	.....	2.00
	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.25
Pipe fitter boss	.....	.....	.....	.....	.....	.....	5.50	.....	5.50	.....
Pipe fitter	.....	2.50	.....	.....	.....	.....	4.50	.....	4.25	.....
" " helpers	.....	.....	.....	.....	.....	.....	3.00	2.25	3.00	.....

A—American. M—Mexican. [1] Eight hours. [2] Nine hours.

Wage Scale

Occupation	Feb. 28, 1912, Ten Hours		April 1, 1912, Nine Hours		July 24, 1912, Nine Hours		July 1, 1913, Nine Hours		Sept. 1, 1913, Eight Hours	
Plow holders	.....	.....	2.25	2.25	.....	.....	.....	.....	.....	.....
Plumbers	.....	.....	.....	.....	4.50	.....	.....	.....	.....	.....
" helpers	.....	.....	.....	.....	3.00	.....	.....	.....	.....	.....
Rigger boss	.....	.....	4.50	.....	5.00	.....	.....	.....	.....	.....
Rigger	.....	.....	.....	.....	.....	.....	3.50	.....	4.25	.....
	.....	.....	.....	.....	.....	.....	4.50	.....	.....	.....
" helpers	.....	.....	2.25	2.25	.....	.....	2.25	2.25	2.25	2.25
	.....	.....	.....	.....	.....	.....	2.50	2.50	3.50	3.50
	.....	.....	.....	.....	.....	.....	3.00	3.00	.....	.....
Stone mason boss	.....	.....	.....	3.50	.....	.....	.....	.....	.....	.....
" "	.....	3.00	.....	3.00	.....	3.00	.....	.....	.....	.....
Steam fitters	.....	.....	.....	.....	4.50	.....	.....	.....	.....	.....
" helpers	.....	.....	.....	.....	3.00	.....	.....	.....	.....	.....
Teamsters. 4 and 6 head	.....	.....	3.00	.....	3.00	.....	.....	.....	.....	.....
" 2 head	.....	.....	2.00	2.00	2.25	2.25	3.00	.....	3.00	.....
" fresnos and slips.	2.25	2.25	2.00	2.00	2.50	2.50	.....	.....	.....	.....
" plow	2.75	.....	2.25	2.25	.....	.....	.....	.....	.....	.....
Tinners	.....	.....	.....	.....	4.00	.....	4.50	.....	4.25	.....
" helpers	.....	.....	.....	.....	2.50	2.50	.....	.....	3.00	.....
Tool room man	.....	.....	.....	2.00	2.25	.....	.....	.....	.....	.....
Tool sharpeners	.....	.....	.....	2.50	3.50	.....	4.00	.....	.....	.....
Track boss	.....	.....	.....	.....	4.25	.....	.....	.....	.....	5
Water boys	.....	1.30	....	1.00	2.00	2.00	2.00	2.00	1.75	1.7.
Warehouse help	.....	.....	.....	.....	.....	.....	3.00	2.50	3.00	.....

CHAPTER V

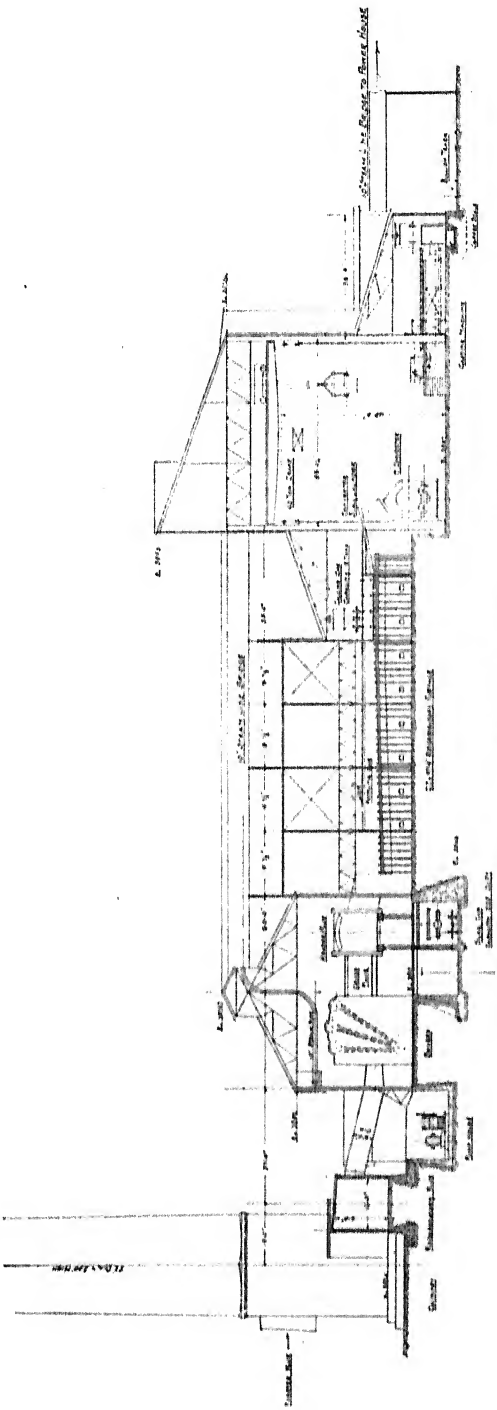
RAW MATERIAL PRICES

Prices of Raw Material F. O. B. Clifton During New Smelter Construction

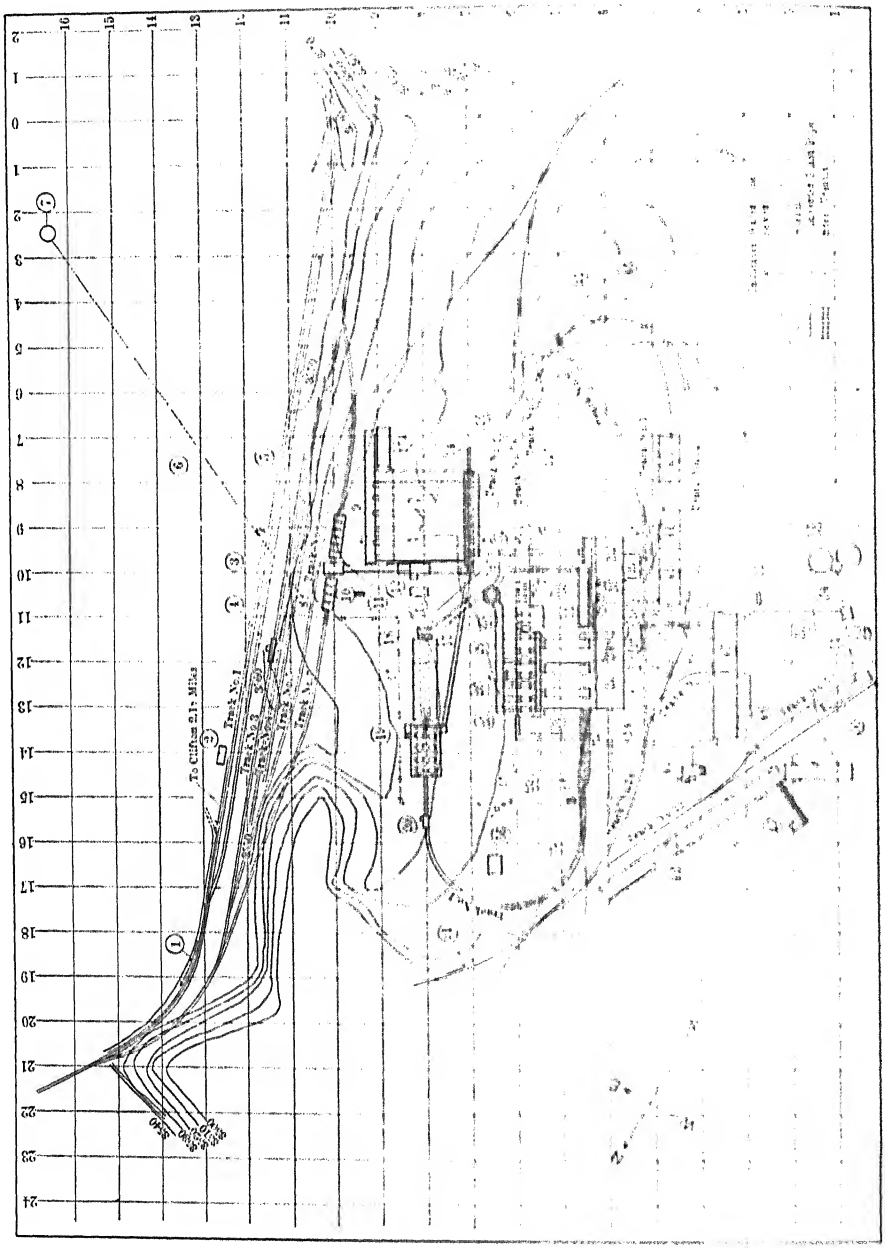
Name	Price	Unit
Asphalt (Trinidad)	$3.62	Cwt.
Asbestos sheets	5.68	"
Brick red standard, 2″ × 4″ × 8″	16.986	M.
" silica A1 straights, 2½″ × 6″ × 12″	98.10	"
" " B 2 " 2½″ × 4½″ × 9″	52.20	"
" " C 2 " 3″ × 6″ × 20″	184.19	"
" " D 1 " 3″ × 6″ × 15″	148.62	"
" Fire "Star", 2½″ × 4½″ × 9″	49.68	"
" " "Athens," 2½″ × 4½″ × 9″	40.00	"
" Magnesite straights, 2½″ × 4½″ × 9″	174.40	"
" " Special shapes at rate of $189.40 per M brick 2½″ × 4½″ × 9″, figuring from cubical contents, *e.g.* "A" special is 2.3796 larger than a 2½″ × 4″ × 9″ brick, therefore would cost 2.3796 × $189.40.		
Bolts, carriage ½″ × 2″	0.97	C.
" machine ½″ × 2″	1.01	"
" " ¾″ × 2″	2.20	"
" " ¾″ × 24	13.04	"
Belting conveyor rubber, 7-5-$\frac{3}{16}$″, 30″ wide	3.63	Lin. ft.
" " " 5-3-$\frac{3}{16}$″, 20″ "	1.9168	"
" " " 6-4-$\frac{3}{16}$″, 20″ "	2.1898	"
Castings, rough iron	2.00 to 3.00	Cwt.
Cement, "El Toro" brand	0.7225	sack

Prices of Raw Material F. O. B. Clifton During New Smelter Construction (*Con.*)

Name	Price	Unit
Clay, fire	$7 00	ton
Coal, steam	$ 00 to 7 175	"
Conduit ¾" galvanized	6 39	C. ft.
Gasoline	0 23	gal.
Grease "Arctic" No. 4	6 50	cwt.
Glass, factory ribbed, 13½" × 20"	13 28	C.
Hay, alfalfa	20 35	ton
Iron, corrugated No. 22, 10-ft. lengths	0 9729	sheet
" galvanized No. 20	3 49	cwt.
" round and square, base	2 35	"
" flat base	2 35	"
" sheets	2 35	"
Lumber, common R. O. P	26 00	M.
" No. 2 T & G flooring	31 76	"
Lead, white	8 80	cwt.
Lime, burnt	10 00	ton
Nails, common, base	2 84	cwt.
Oil, linseed	0 6163	gal.
" coal	0 12	"
Pipe, black 1 in	17 54	M. ft.
" " 2 in	91 84	"
" " 4 in	286 20	"
" " 6 in	516 10	"
" " 8 in	776 87	"
" sewer 6 in	37 94	C. ft
" " 12 in	52 80	"
" " 24 in	104 00	"
Powder, black	7 1008	cwt.
" "Hercules," 30 per cent. ¼" × 8"	11 576 to 12 0754	"
Rails, 60, second-hand	37 50	ton
Rope, Manila, base	10 50	cwt.
Sand and gravel	1 00 ave	cu. yd.
Shafting 3-$\frac{11}{16}$ C.R	3 78	cwt.
Silicate of soda	12 182	bbl.
Steel structure	3 11	cwt.
Ties, white oak	1 05	each
Tile, 4 × 8 × 12", "El Paso"	58 742	M.
Valves, gate brass "Crane" 1 in	71 06	C.
" " " " 2 in	208 50	"
" " " " 3 in	6 20	each
" " 1B " 3 in	4 98	"
Wire, No. 12 weatherproof	23 18	cwt.
" No. 4 double braid stranded	56 50	M. ft.
" No. 12 galvanized	6 195	cwt.



CROSS-SECTION THROUGH REVERBERATORIES AND CONVERTERS.

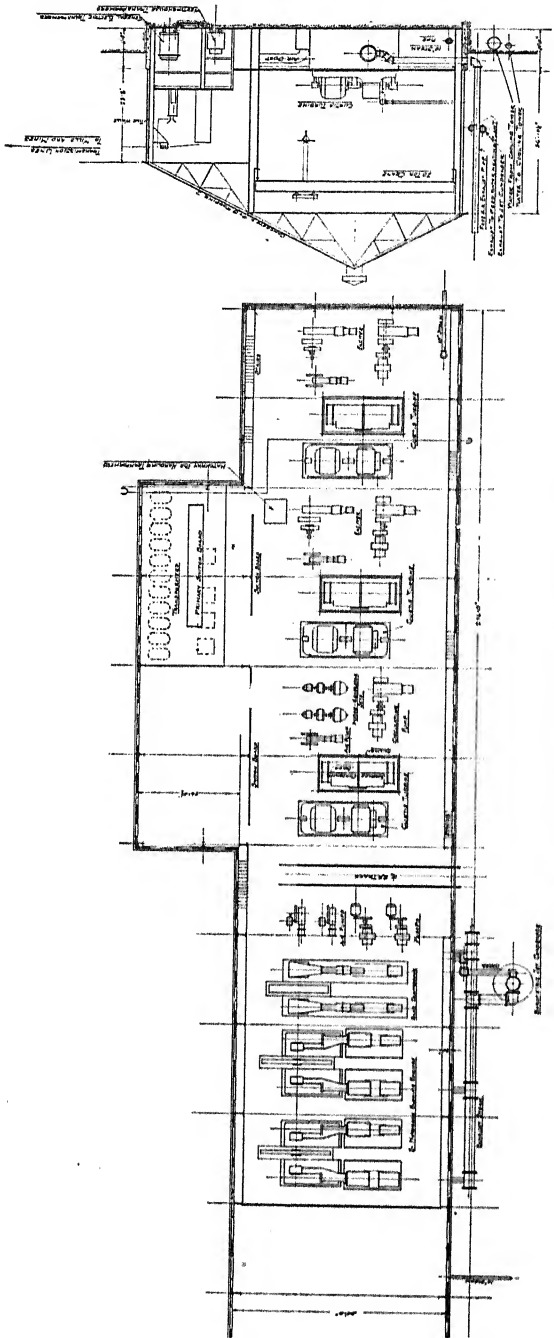


GENERAL PLAN OF SMELTER.
Numbers in circles refer to list on opposite page.

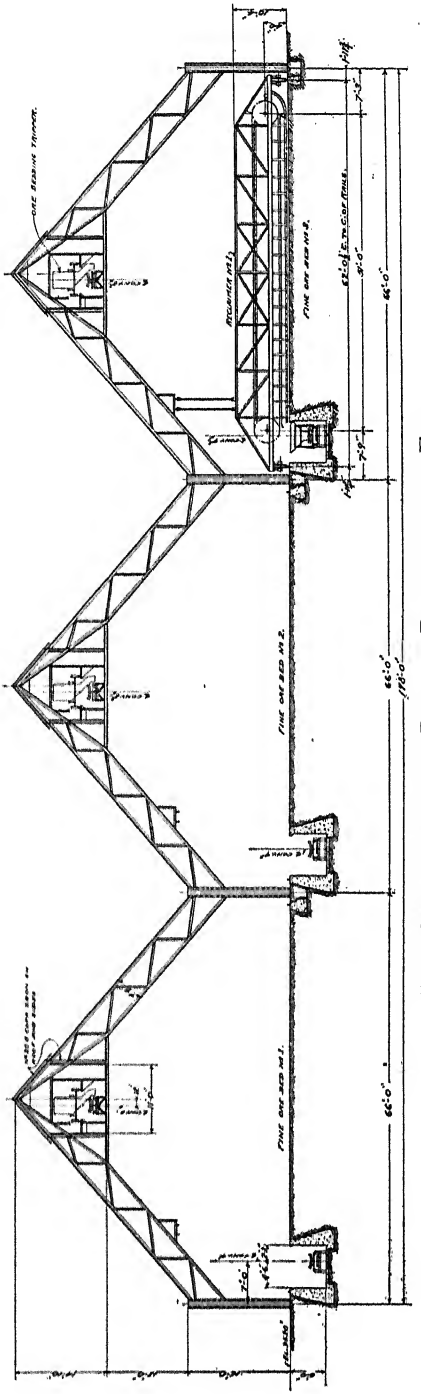
REFERENCE LIST FOR GENERAL PLAN OF SMELTER

(See Opposite Page)

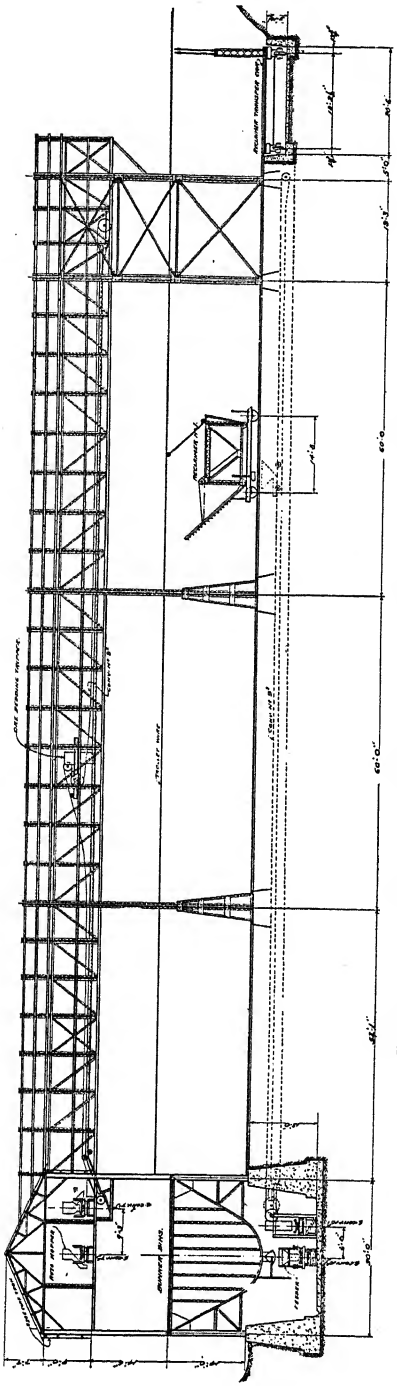
1. Drainage Ditch
2. Depot
3. 6-in. Water Main from Clifton
4. 150-ton Track Scales
5. A. N. M. Main Line
6. 6-in. Water Pipe
7. 250,000-gal. Water Tank
8. Receiving Bins
9. Transfer Pit
10. Crushing Plant
11. Outside Closet
12. Sampling Mill
13. Sample Room
14. Three Spreading Beds
15. Reclaimer House
16. Bunker Bins
17. Roaster Flue
18. Roaster Dust Chamber
19. Roasters
20. 40-ton Track Scale
21. To Slag Dump
22. Calcine Trestle
23. 8-in. Hot-water Line
24. Outside Closet
25. Feed-water Pump House
26. Reverberatory Flue
27. Chimney
28. 163-barrel Oil Tanks
29. Boiler Building
30. Reverberatories
31. Converter Dust Chamber
32. Silica Bins
33. Converter Flue
34. Steam Line
35. Converter Building
36. Converters
37. Casting Shed
38. Bullion Scales
39. Casting Shed
40. 24-in. Blast Pipe
41. Heater House
42. Cooling Tower
43. Machine Shop
44. Boiler Shop
45. Warehouse
46. Culvert
47. Power House
48. Power House Tunnel
49. Condensed Water Pump House
50. Oil Sump
51. 16-in. Oil Pipe
52. Oil Pump House
53. 500,000-gal. Oil Tanks
54. 8-in. Oil Pipe
55. 2 1/2-in. Steam Pipe
56. Assay Office



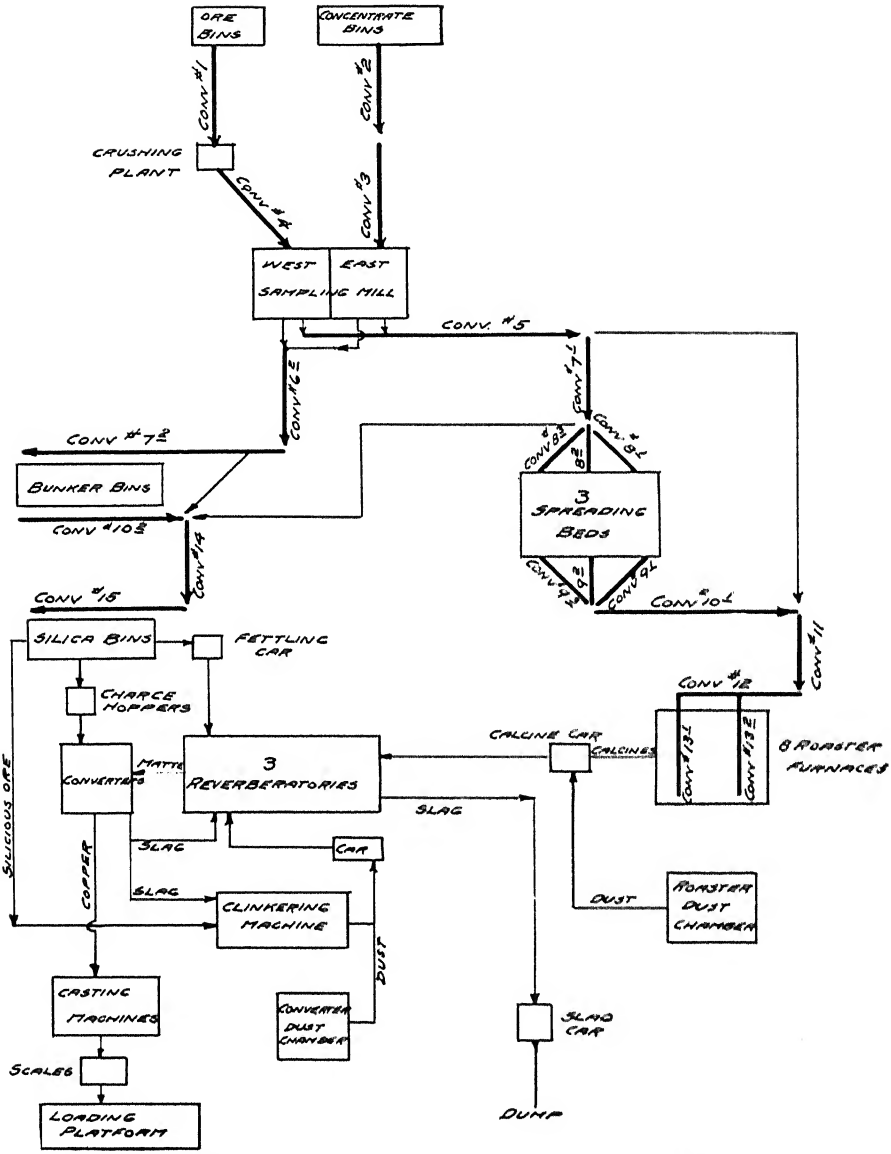
PLAN AND CROSS-SECTION OF POWER HOUSE.



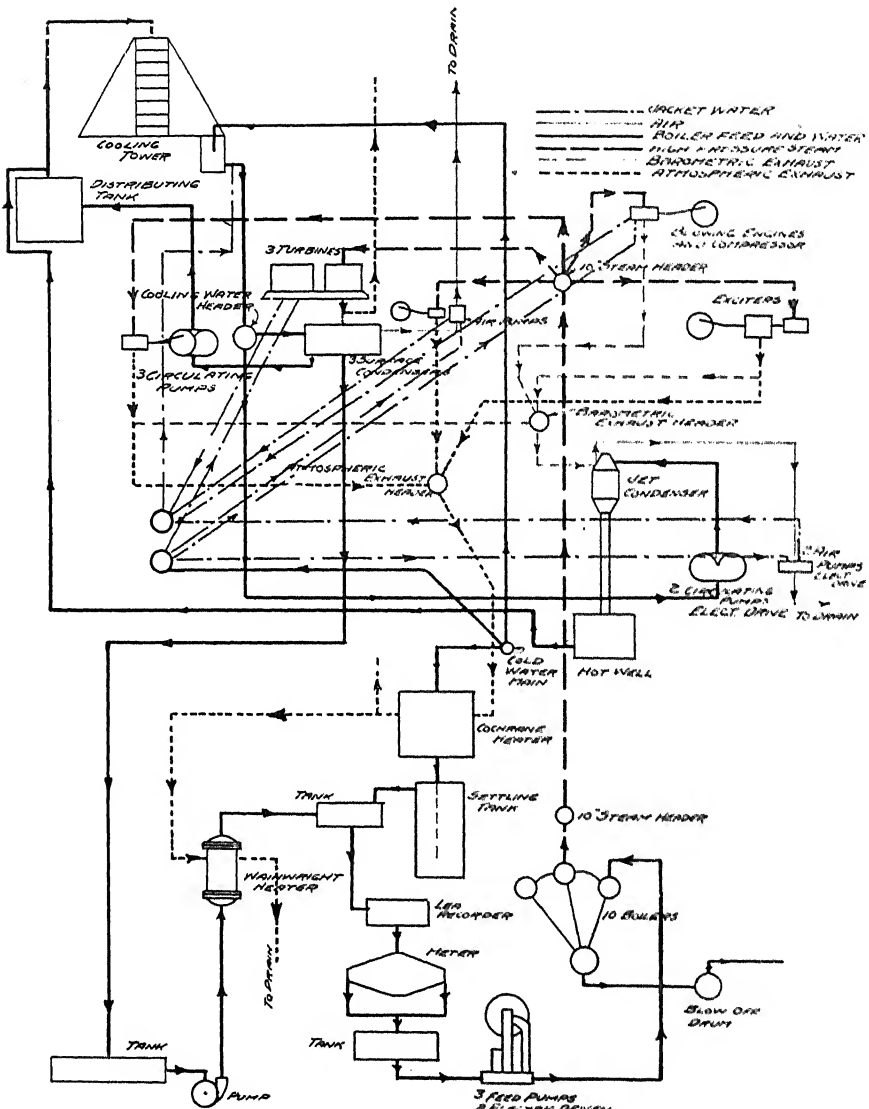
CROSS-SECTION THROUGH BEDDING PLANT, LOOKING EAST.



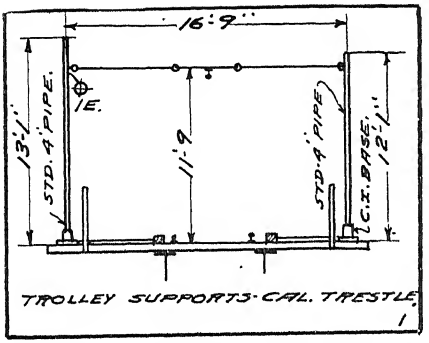
LONGITUDINAL SECTION THROUGH BEDDING PLANT, LOOKING NORTH.



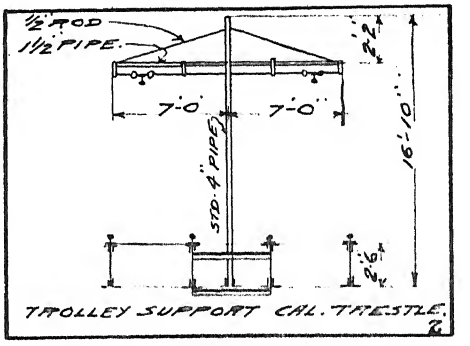
FLOW SHEET OF SMELTER. HEAVY LINES REPRESENT CONVEYORS.



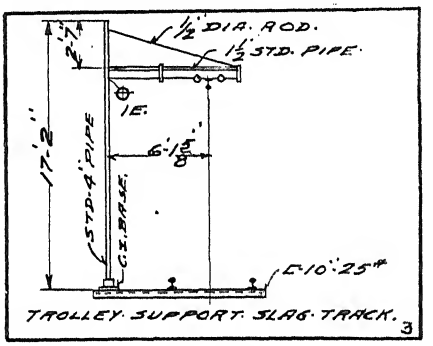
FLOW SHEET OF PIPING.



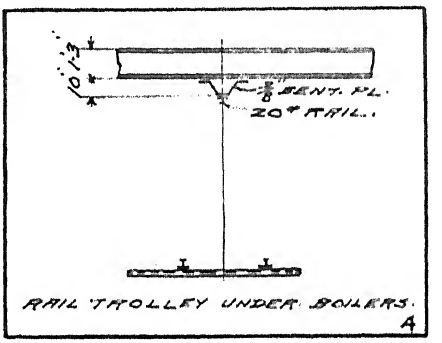
TROLLEY SUPPORTS CAL. TRESTLE. 1



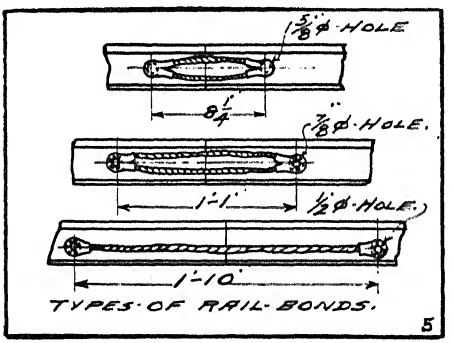
TROLLEY SUPPORT CAL. TRESTLE. 2



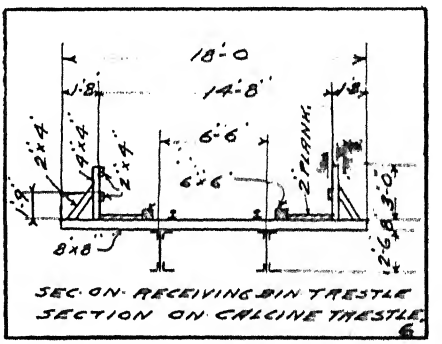
TROLLEY SUPPORT SLAB TRACK. 3



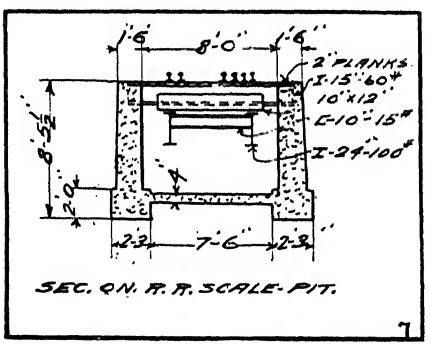
RAIL TROLLEY UNDER BOILERS. 4



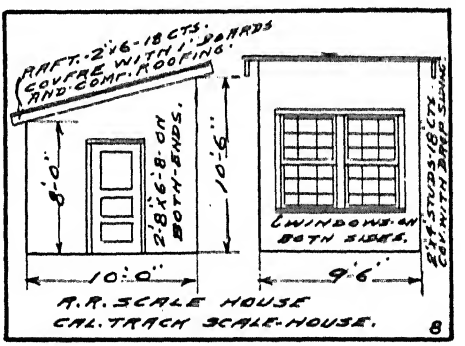
TYPES OF RAIL BONDS. 5



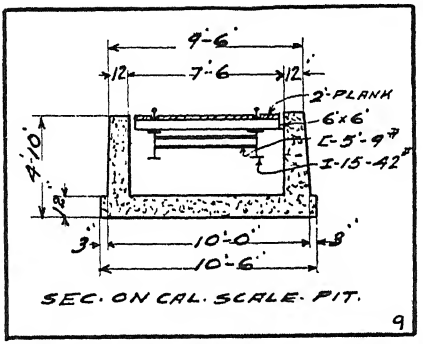
SEC. ON RECEIVING BIN TRESTLE
SECTION ON CALCINE TRESTLE. 6



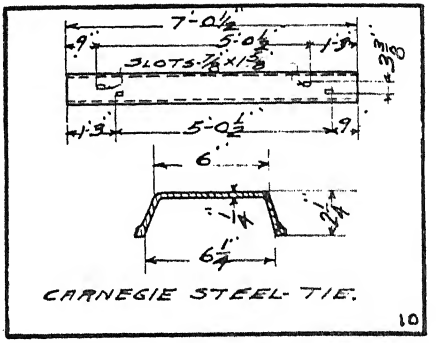
SEC. ON R. R. SCALE PIT. 7



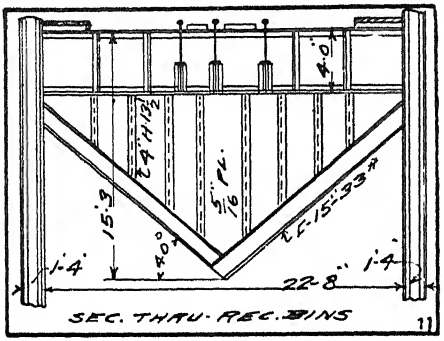
R. R. SCALE HOUSE
CAL. TRACK SCALE HOUSE. 8



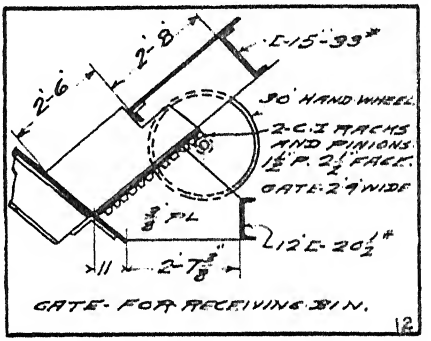
SEC. ON CAL. SCALE. PIT. 9



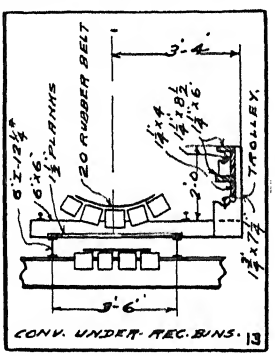
CARNEGIE STEEL TIE. 10



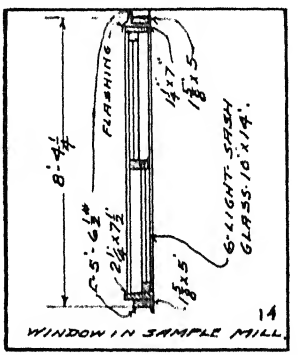
SEC. THRU REC. BINS 11



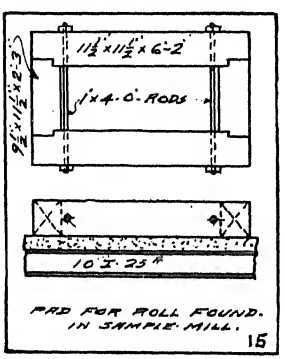
GATE FOR RECEIVING BIN. 12



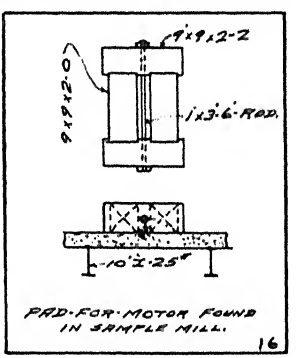
CONV. UNDER REC. BINS. 13



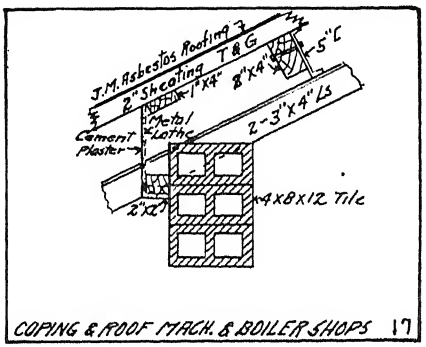
WINDOW IN SAMPLE MILL. 14



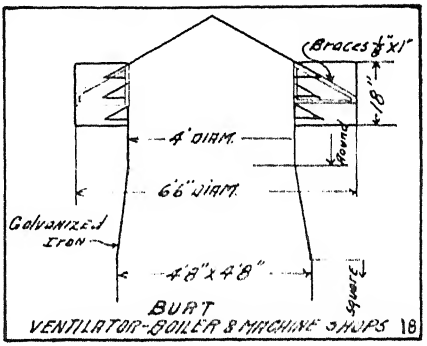
PAD FOR ROLL FOUND. IN SAMPLE MILL. 15



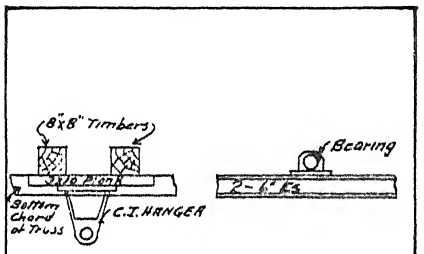
PAD FOR MOTOR FOUND IN SAMPLE MILL. 16



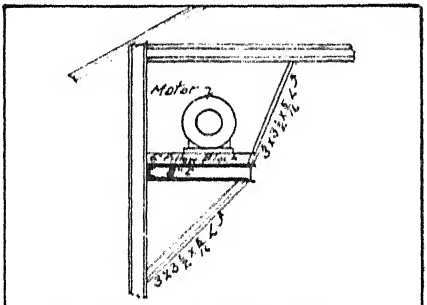
COPING & ROOF MACH. & BOILER SHOPS 17



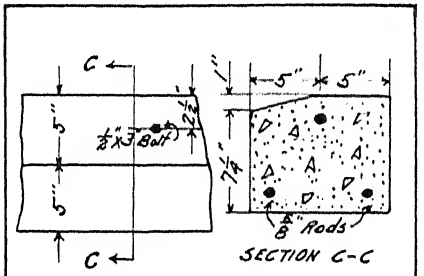
BURT
VENTILATOR-BOILER & MACHINE SHOPS 18



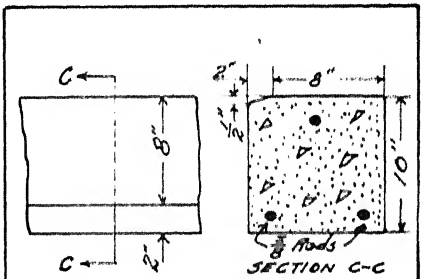
19
SHAFTING SUPPORTS MACH. & BOILER SHOPS



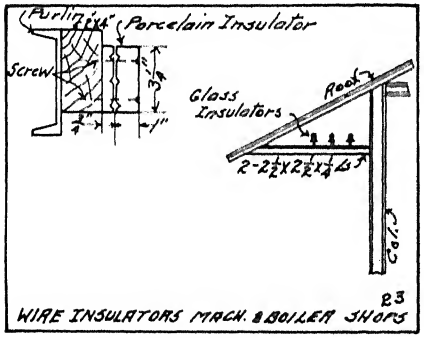
MOTOR SUPPORT MACH. & BOILER SHOPS 20



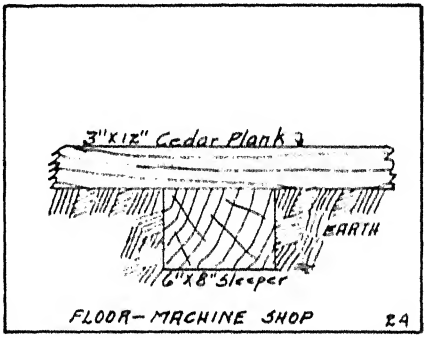
21
CONCRETE SILLS MACH. & BOILER SHOPS



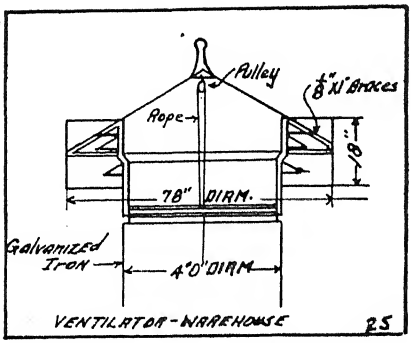
CONCRETE SILLS WAREHOUSE 22



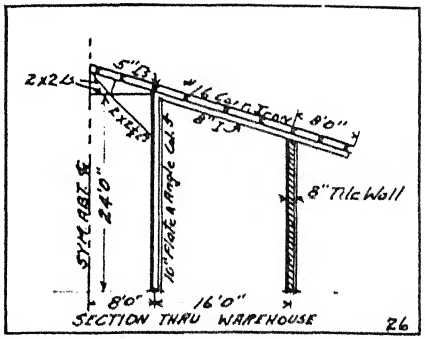
23
WIRE INSULATORS MACH. & BOILER SHOPS



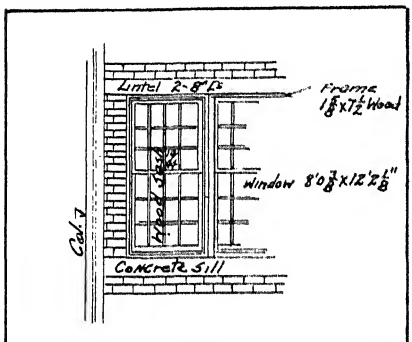
FLOOR—MACHINE SHOP 24



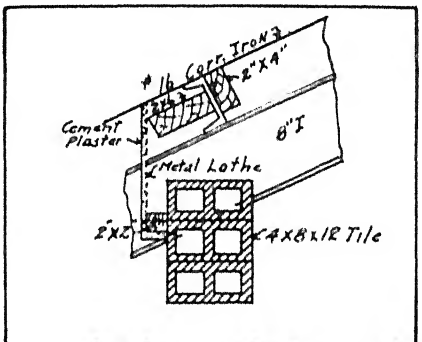
VENTILATOR - WAREHOUSE 25



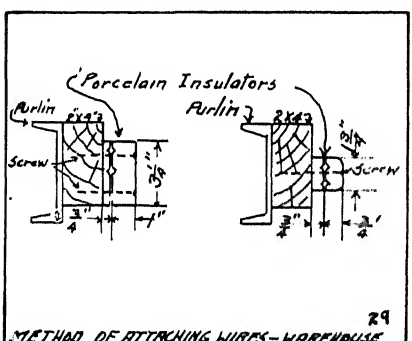
SECTION THRU WAREHOUSE 26



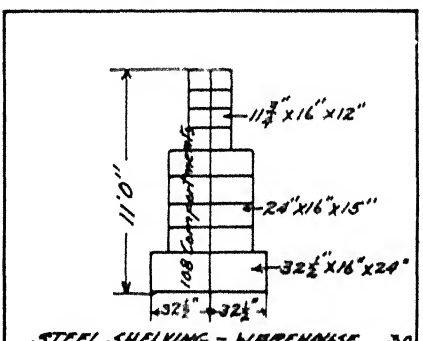
WINDOW - WAREHOUSE 27



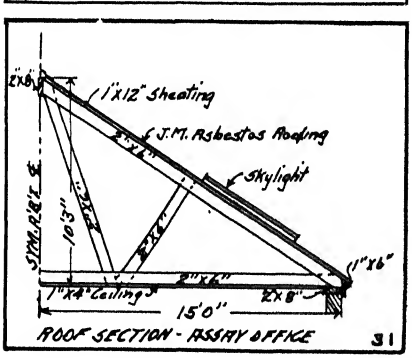
COPING & ROOF WAREHOUSE 28



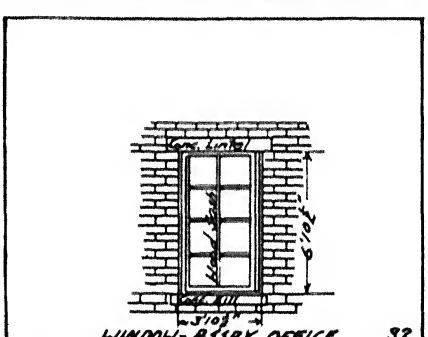
29
METHOD OF ATTACHING WIRES - WAREHOUSE



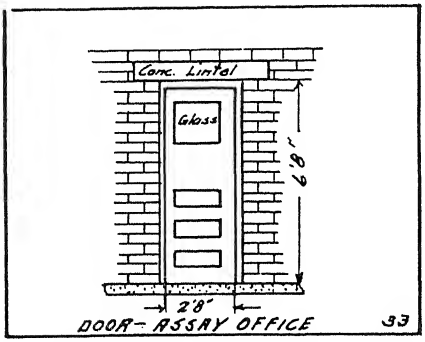
STEEL SHELVING - WAREHOUSE 30



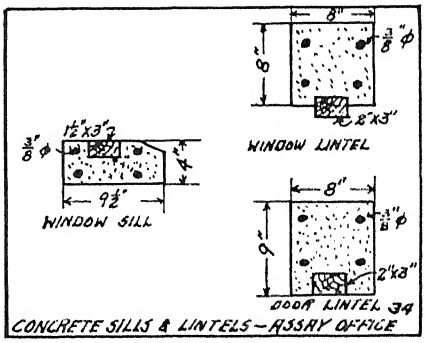
ROOF SECTION - ASSAY OFFICE 31



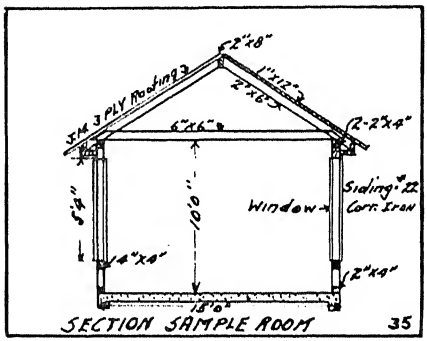
WINDOW - ASSAY OFFICE 32



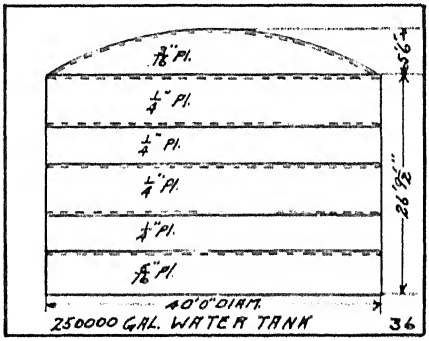
DOOR—ASSAY OFFICE 33



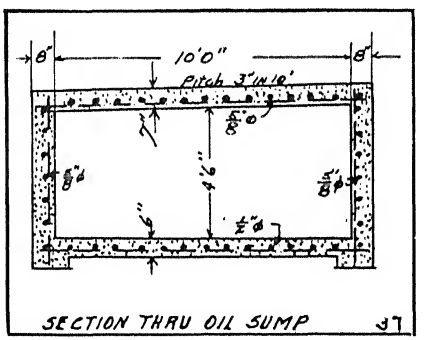
CONCRETE SILLS & LINTELS—ASSAY OFFICE



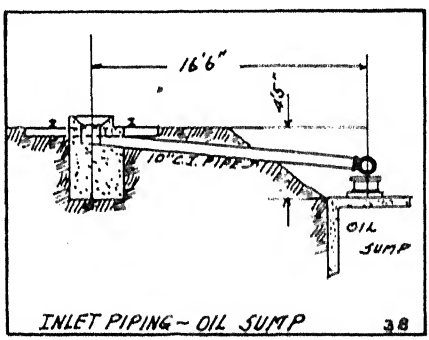
SECTION SAMPLE ROOM 35



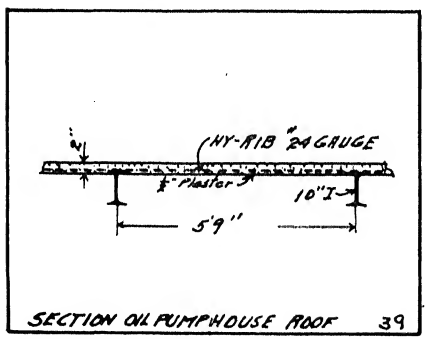
250000 GAL. WATER TANK 36



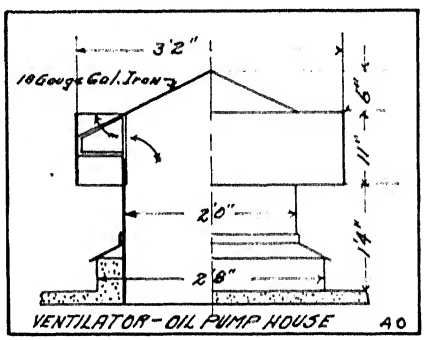
SECTION THRU OIL SUMP 37



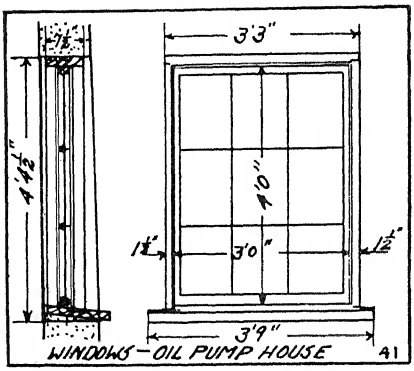
INLET PIPING—OIL SUMP 38



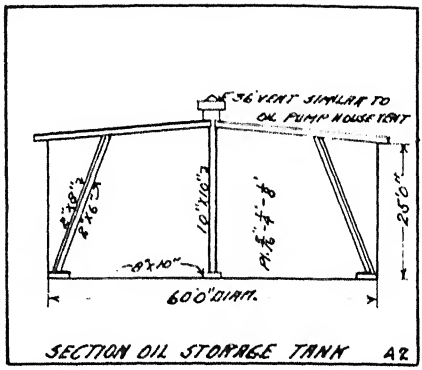
SECTION OIL PUMPHOUSE ROOF 39



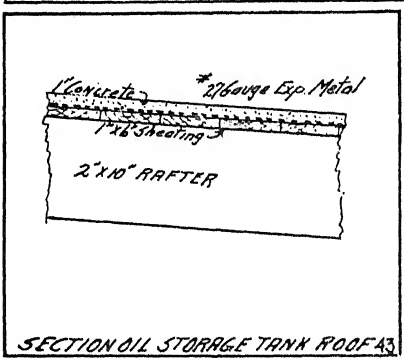
VENTILATOR—OIL PUMP HOUSE 40



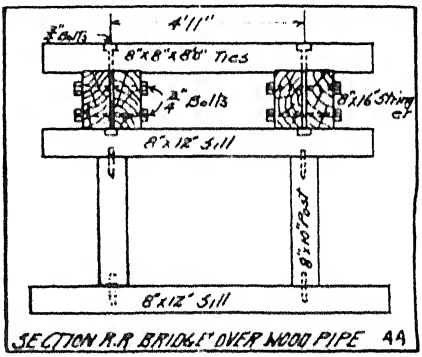
WINDOWS—OIL PUMP HOUSE 41



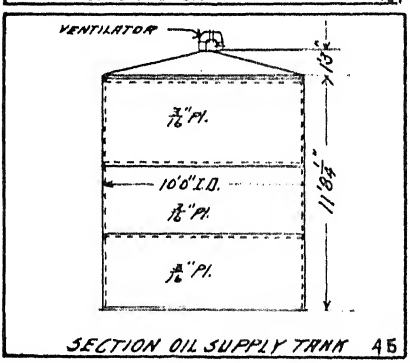
SECTION OIL STORAGE TANK 42



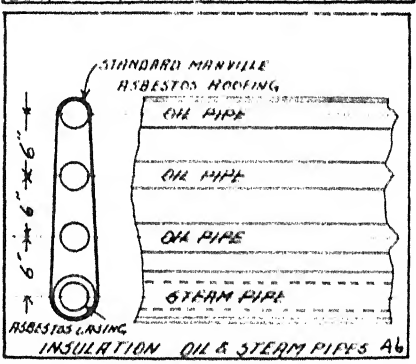
SECTION OIL STORAGE TANK ROOF 43



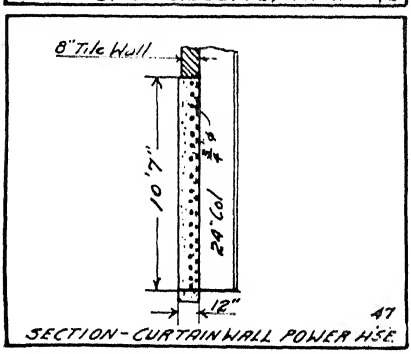
SECTION R.R. BRIDGE OVER WOOD PIPE 44



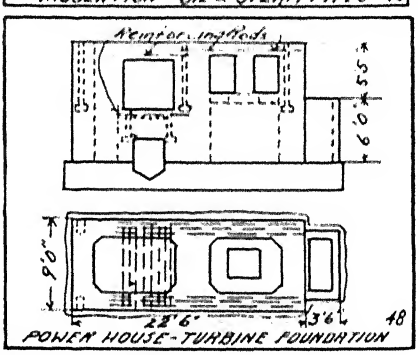
SECTION OIL SUPPLY TANK 45



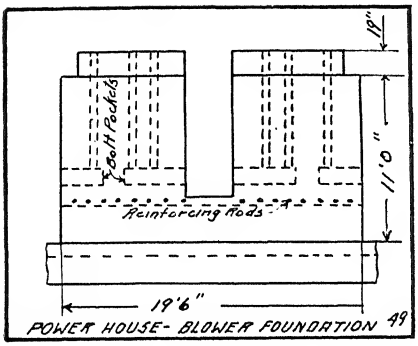
INSULATION OIL & STEAM PIPES 46



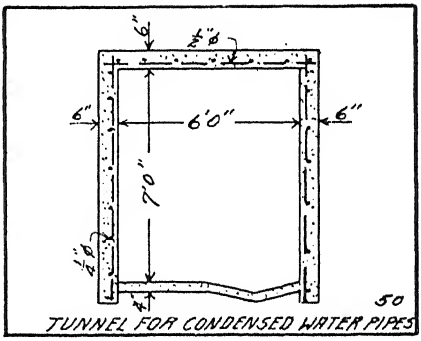
SECTION—CURTAIN WALL POWER HSE. 47



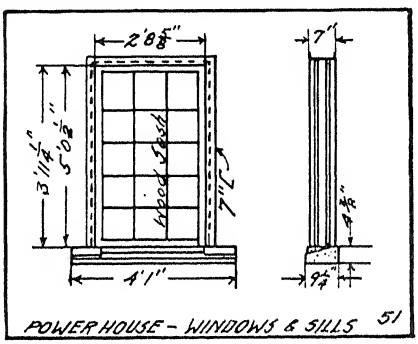
POWER HOUSE—TURBINE FOUNDATION 48



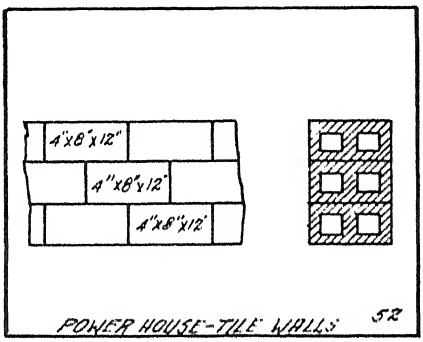
POWER HOUSE - BLOWER FOUNDATION 49



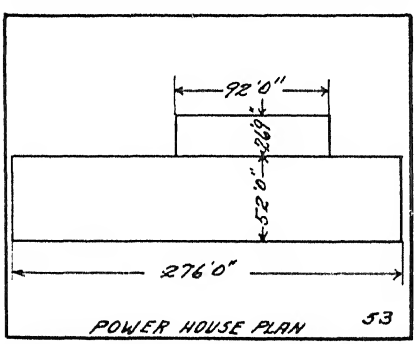
50
TUNNEL FOR CONDENSED WATER PIPES



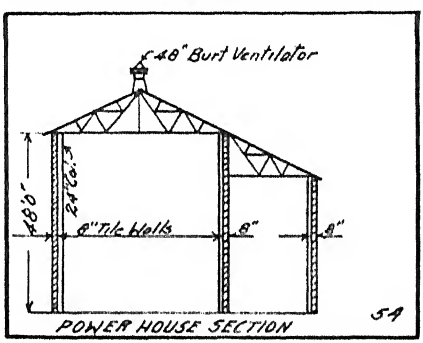
POWER HOUSE - WINDOWS & SILLS 51



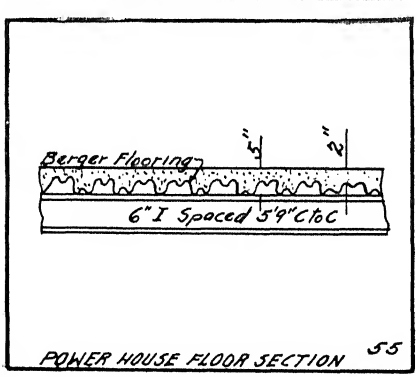
POWER HOUSE - TILE WALLS 52



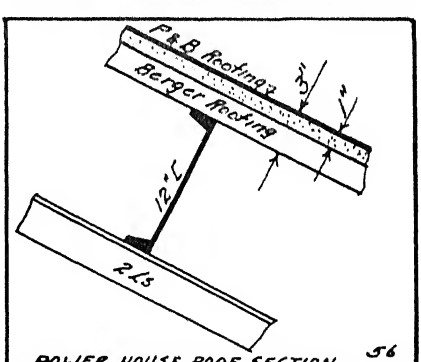
POWER HOUSE PLAN 53



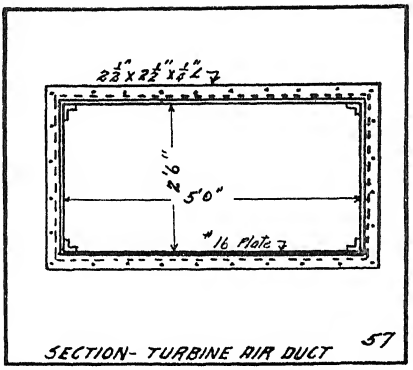
POWER HOUSE SECTION 54



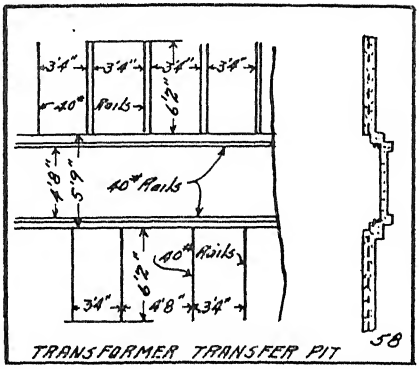
POWER HOUSE FLOOR SECTION 55



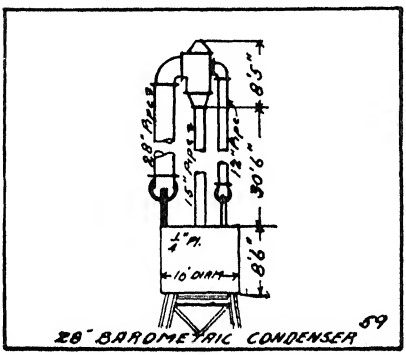
POWER HOUSE ROOF SECTION 56



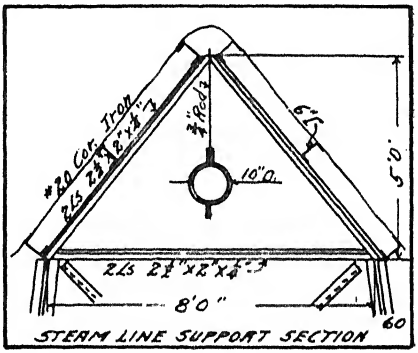
SECTION- TURBINE AIR DUCT 57



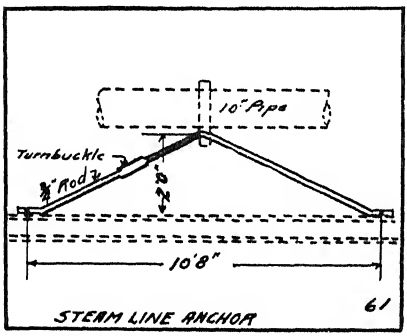
TRANSFORMER TRANSFER PIT 58



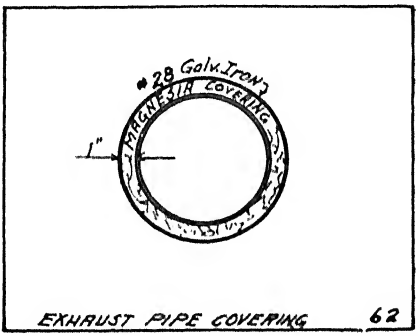
28" BAROMETRIC CONDENSER 59



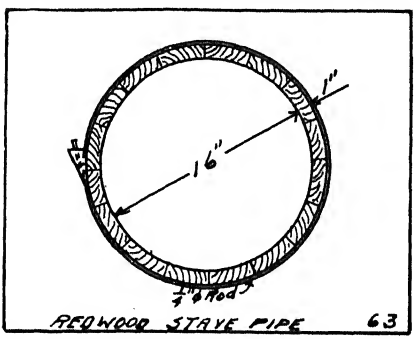
STEAM LINE SUPPORT SECTION 60



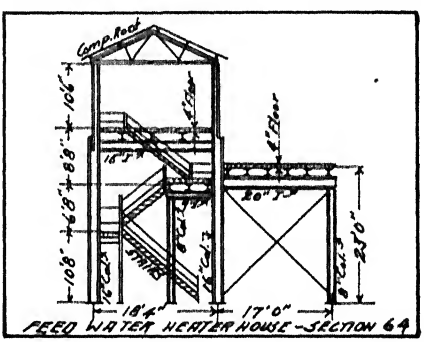
STEAM LINE ANCHOR 61



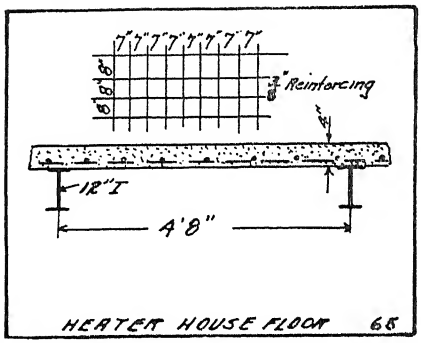
EXHAUST PIPE COVERING 62



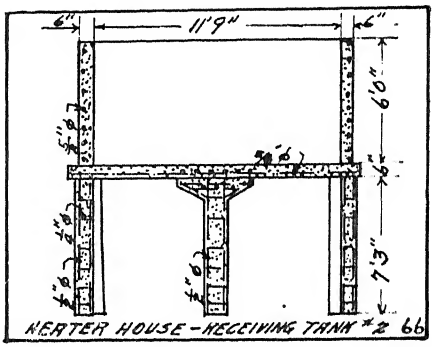
REDWOOD STAVE PIPE 63



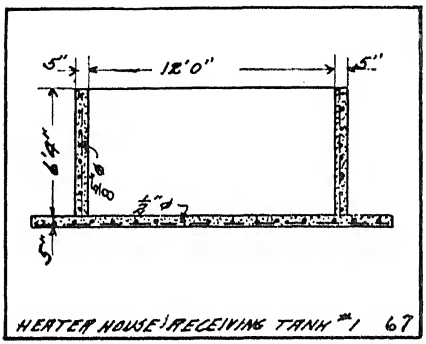
FEED WATER HEATER HOUSE - SECTION 64



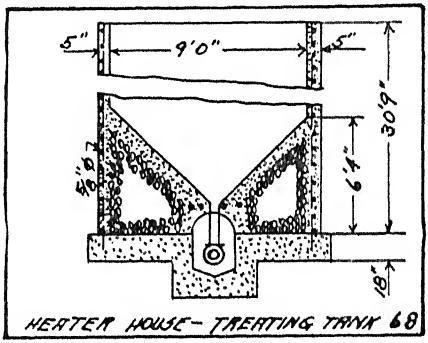
HEATER HOUSE FLOOR 65



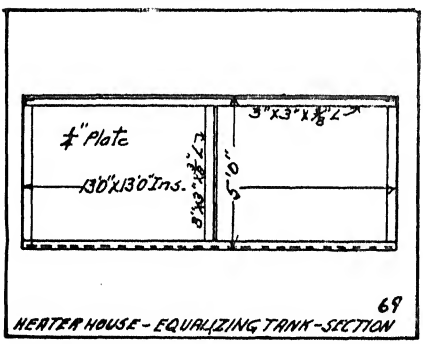
HEATER HOUSE-RECEIVING TANK #2 66



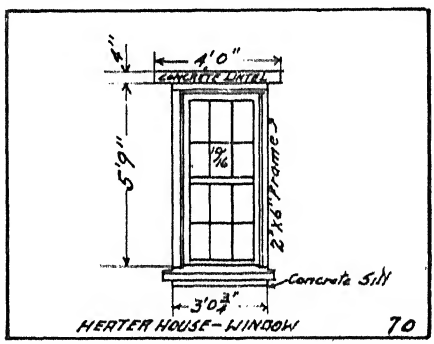
HEATER HOUSE-RECEIVING TANK #1 67



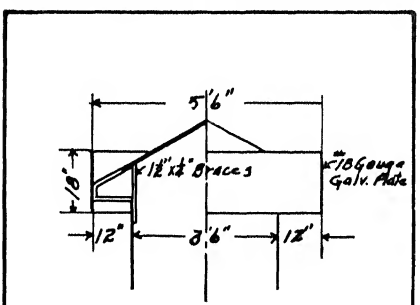
HEATER HOUSE-TREATING TANK 68



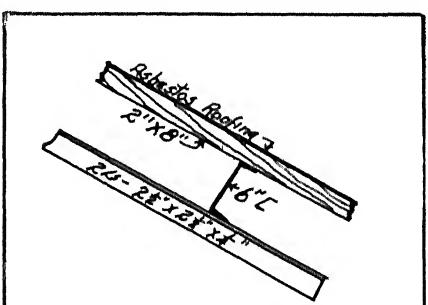
69
HEATER HOUSE-EQUALIZING TANK-SECTION



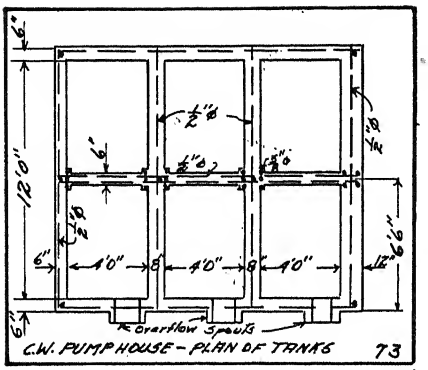
HEATER HOUSE-WINDOW 70



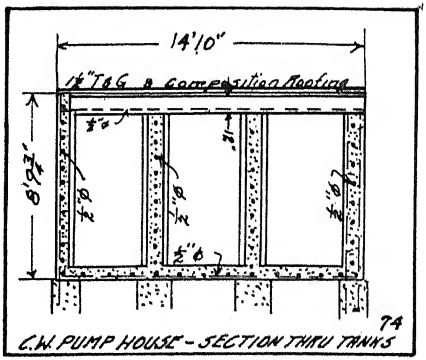
HEATER HOUSE-VENTILATOR 71



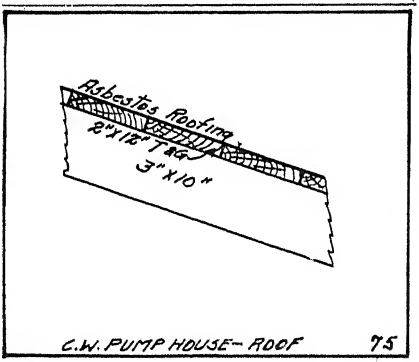
HEATER HOUSE-ROOF 72



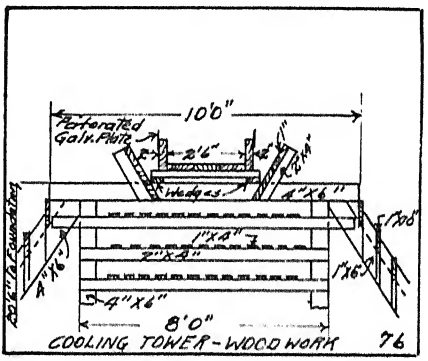
C.W. PUMP HOUSE - PLAN OF TANKS 73



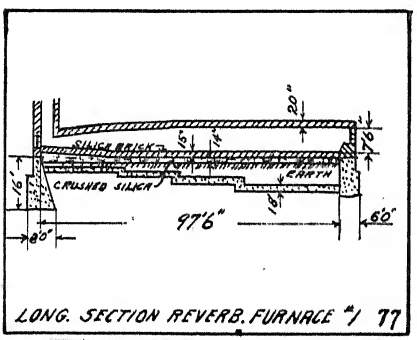
C.W. PUMP HOUSE - SECTION THRU TANKS 74



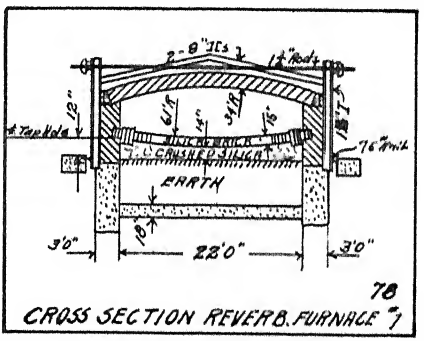
C.W. PUMP HOUSE - ROOF 75



COOLING TOWER - WOOD WORK 76

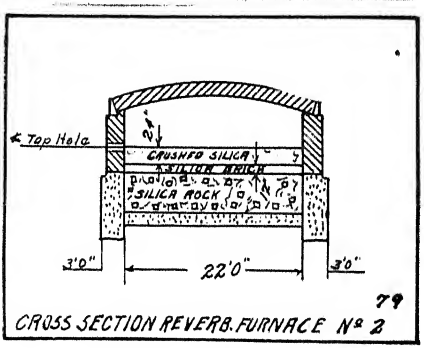


LONG. SECTION REVERB. FURNACE #1 77



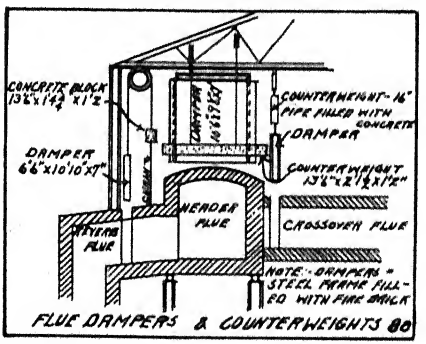
78

CROSS SECTION REVERB. FURNACE #1

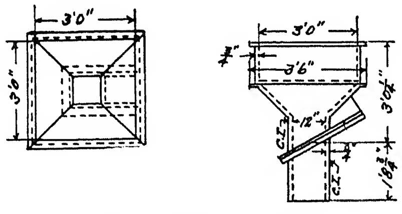


79

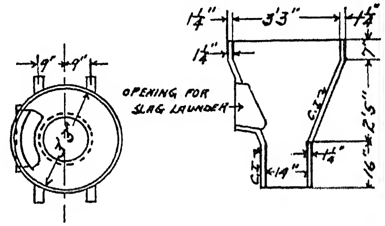
CROSS SECTION REVERB. FURNACE Nº 2



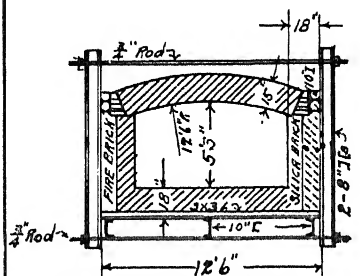
FLUE DAMPERS & COUNTERWEIGHTS 80



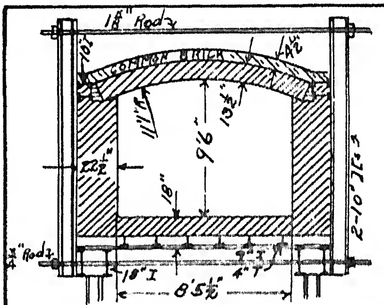
REVERB. CALCINE HOPPER 81



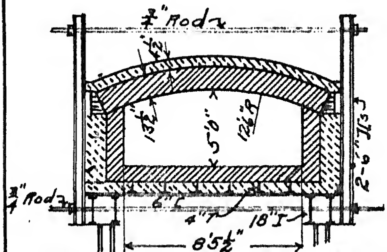
REVERB. SLAG HOPPER 82



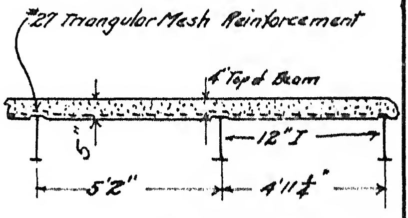
CROSS SECTION - CROSS FLUE 83



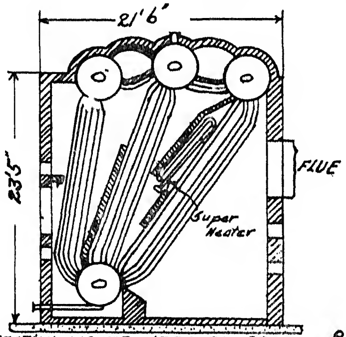
CROSS SECTION HEADER FLUE 84



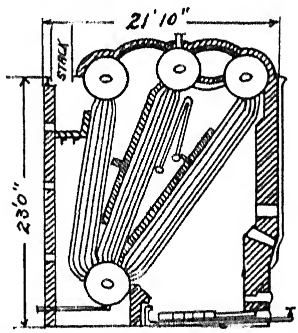
CROSS SECTION CROSSOVER FLUE 85



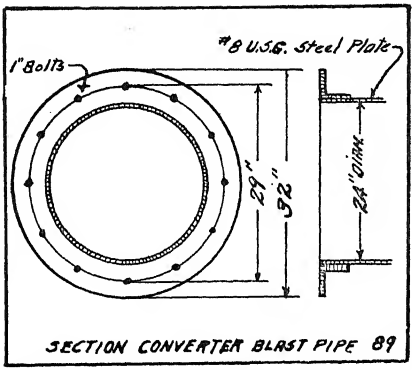
SECTION THRU FLOOR OVER SLAG TRACK 86



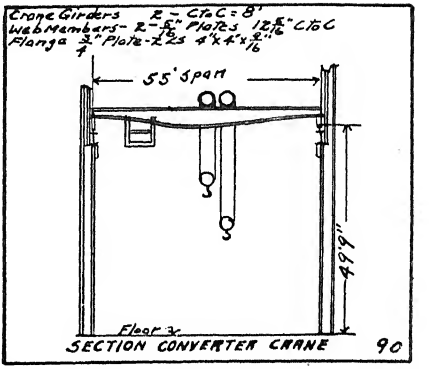
SECTION WASTE HEAT BOILER 87



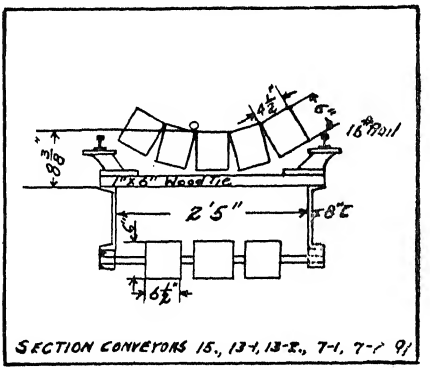
SECTION OIL FIRED BOILER 88



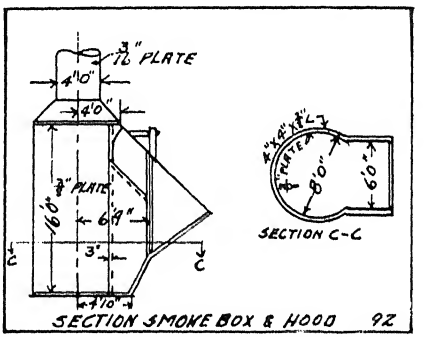
SECTION CONVERTER BLAST PIPE 89



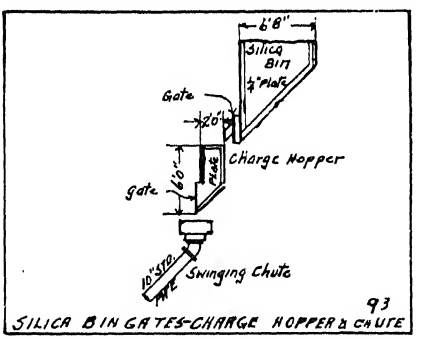
SECTION CONVERTER CRANE 90



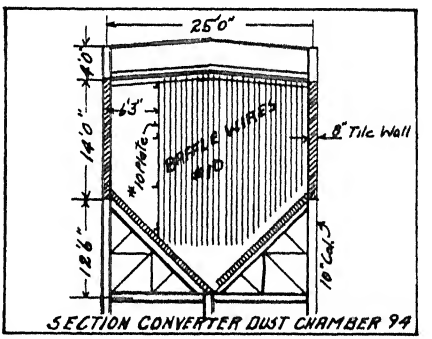
SECTION CONVEYORS 15., 13-1, 13-2., 7-1, 7-2 91



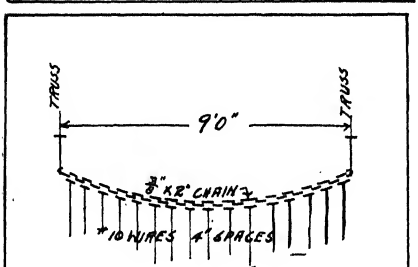
SECTION SMOKE BOX & HOOD 92



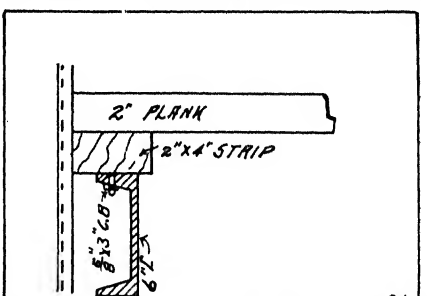
93
SILICA BIN GATES-CHARGE HOPPER & CHUTE



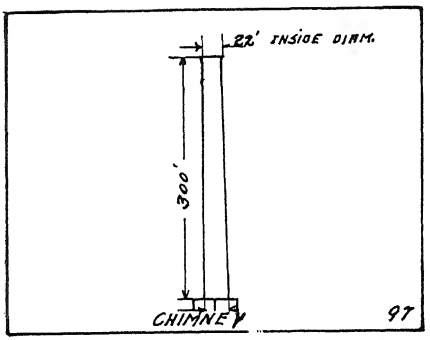
SECTION CONVERTER DUST CHAMBER 94



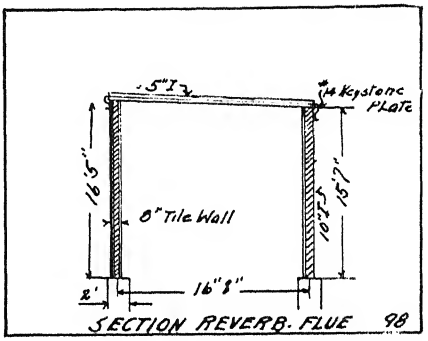
BAFFLE WIRE SUPPORTS 95



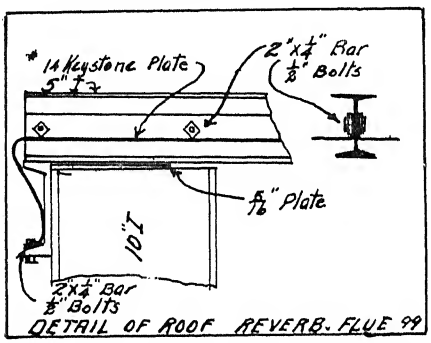
96
METHOD OF ATTACHING CONVEYOR FLOOR TO STEEL



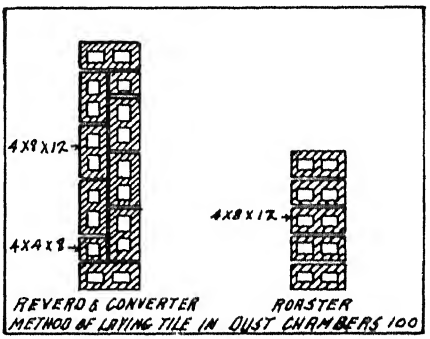
CHIMNEY 97



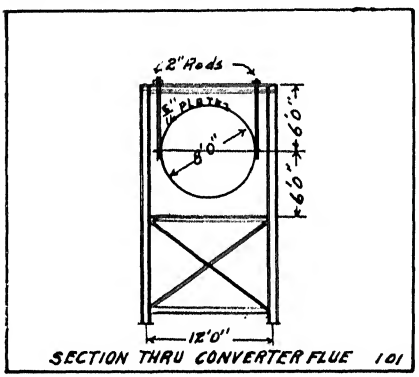
SECTION REVERB. FLUE 98



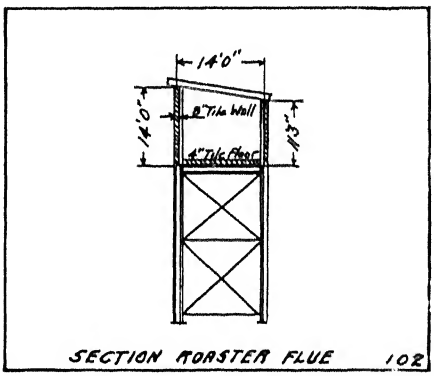
DETAIL OF ROOF REVERB. FLUE 99



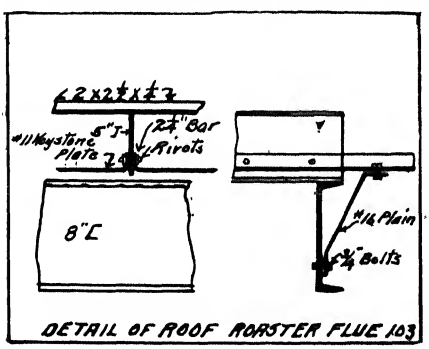
REVERB & CONVERTER ROASTER
METHOD OF LAYING TILE IN DUST CHAMBERS 100



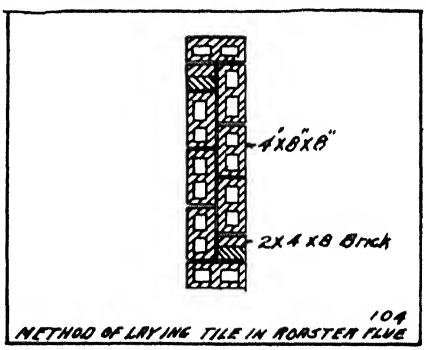
SECTION THRU CONVERTER FLUE 101



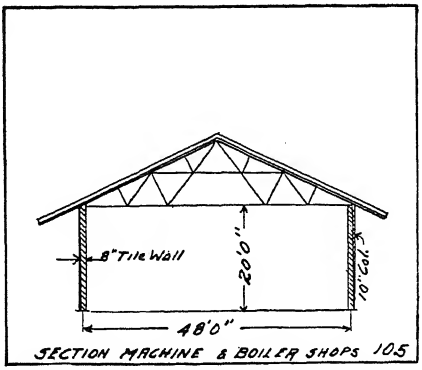
SECTION ROASTER FLUE 102



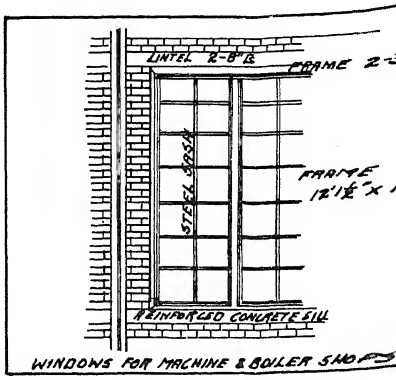
DETAIL OF ROOF ROASTER FLUE 103



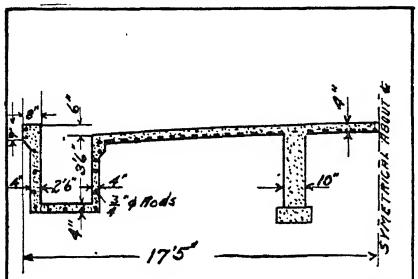
104
METHOD OF LAYING TILE IN ROASTER FLUE



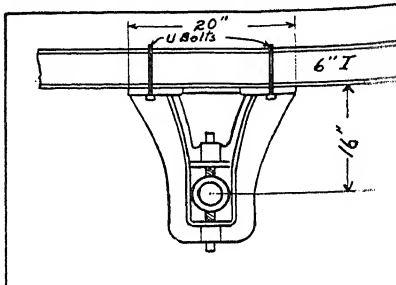
SECTION MACHINE & BOILER SHOPS 105



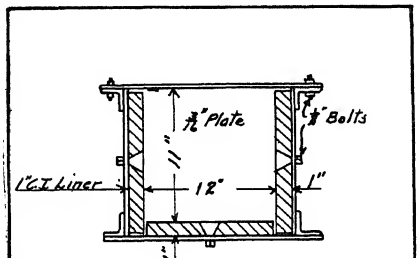
WINDOWS FOR MACHINE & BOILER SHOPS



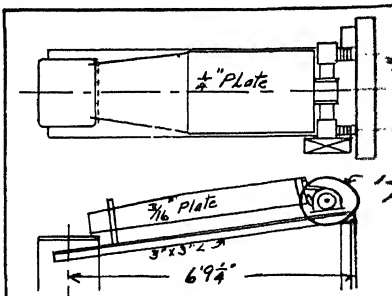
107
SECTION-COOLING TOWER FOUNDATION



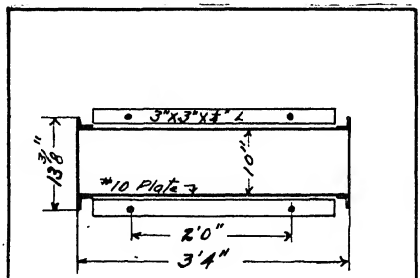
SHAFT HANGER - SAMPLE MILL



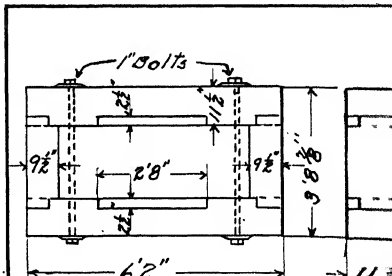
SECTION SAMPLE MILL CHUTES 109



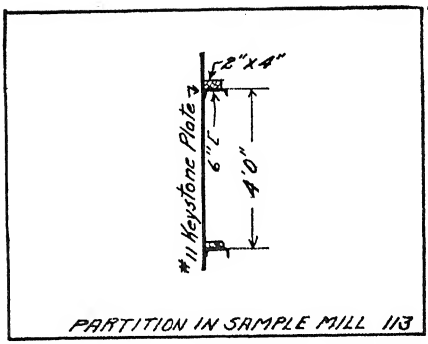
SHAKING FEEDER - SAMPLE MILL



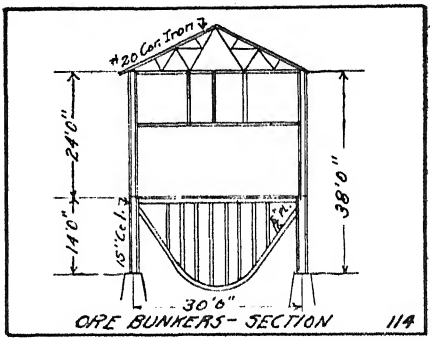
ELEVATOR SECTION - SAMPLE MILL 111



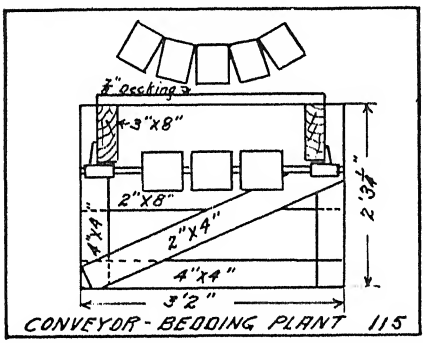
PADS FOR ROLLS - SAMPLE MILL



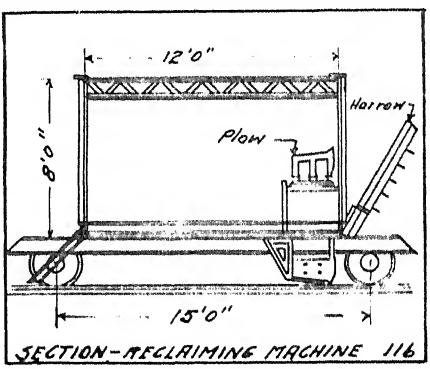
PARTITION IN SAMPLE MILL 113



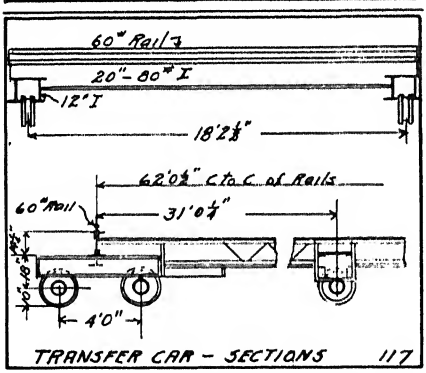
ORE BUNKERS - SECTION 114



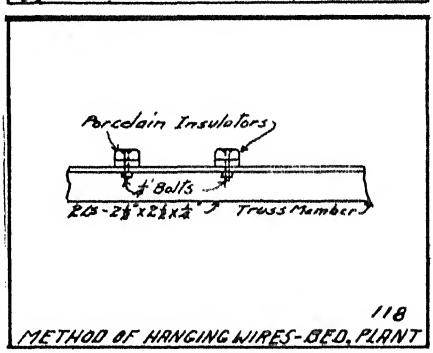
CONVEYOR - BEDDING PLANT 115



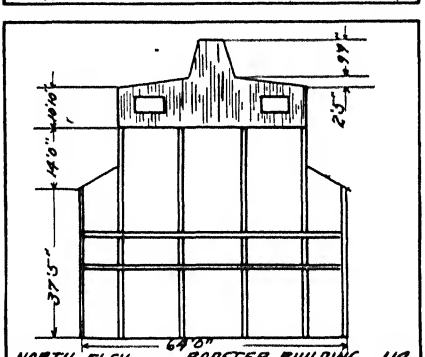
SECTION - RECLAIMING MACHINE 116



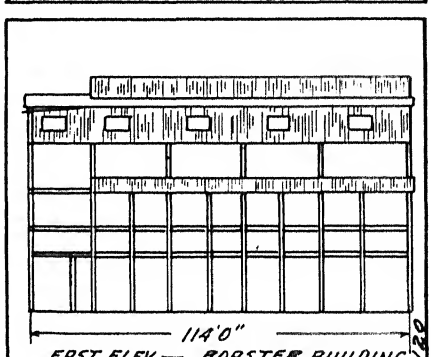
TRANSFER CAR - SECTIONS 117



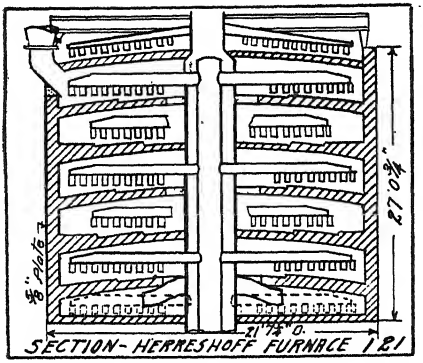
118
METHOD OF HANGING WIRES - BED. PLANT

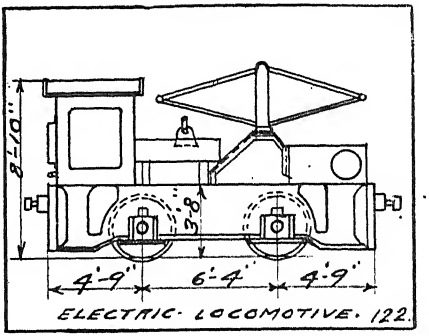


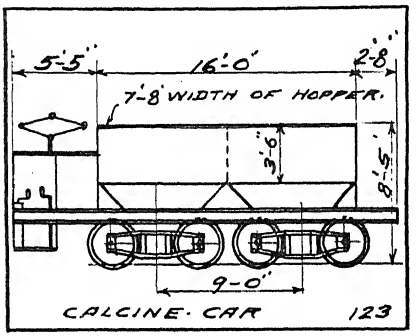
NORTH ELEV. - ROASTER BUILDING 119

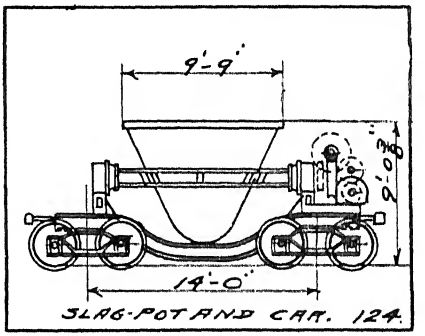


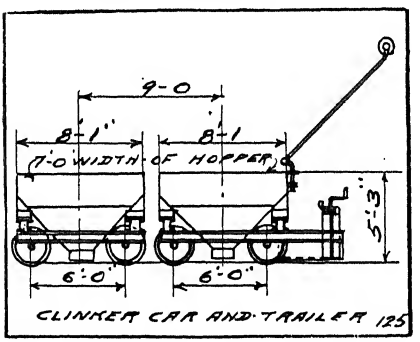
EAST ELEV — ROASTER BUILDING 120

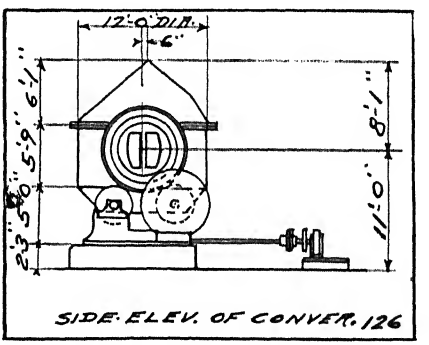

SECTION-HERRESHOFF FURNACE 121

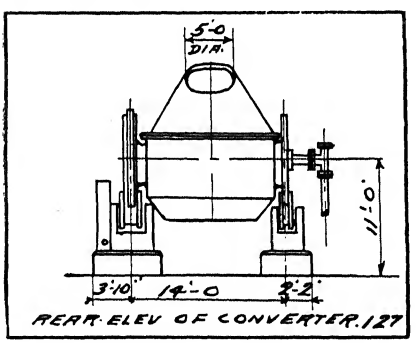

ELECTRIC LOCOMOTIVE. 122.

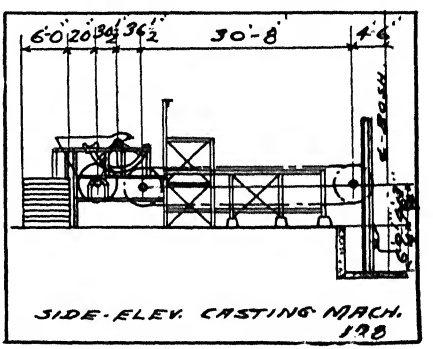

CALCINE CAR 123

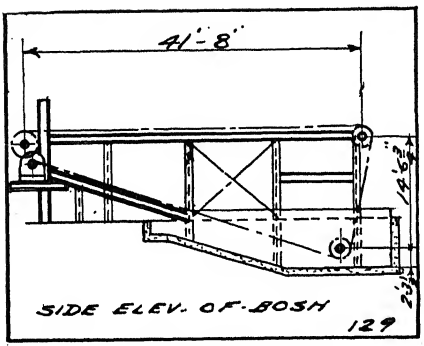

SLAG POT AND CAR. 124.


CLINKER CAR AND TRAILER 125

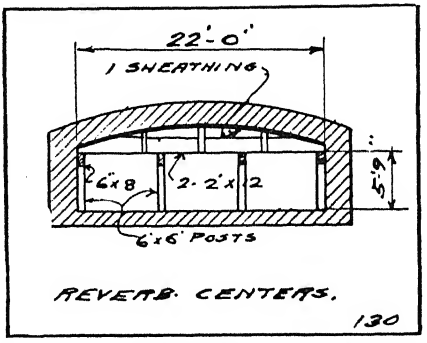

SIDE ELEV. OF CONVER. 126


REAR ELEV OF CONVERTER. 127

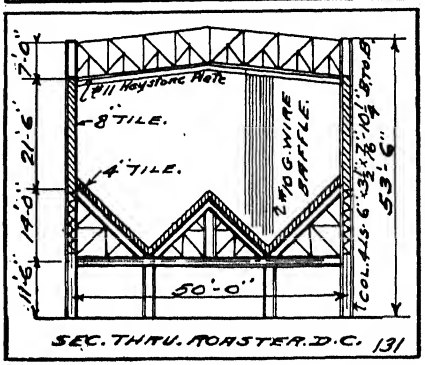

SIDE ELEV. CASTING MACH. 128



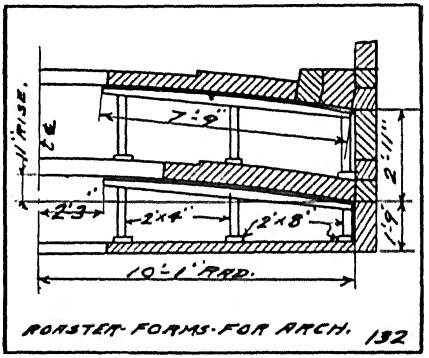
SIDE ELEV. OF BOSH 129



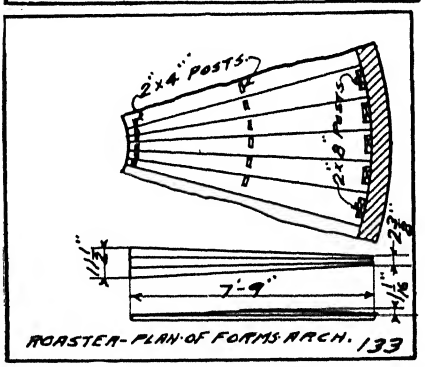
REVERB. CENTERS. 130



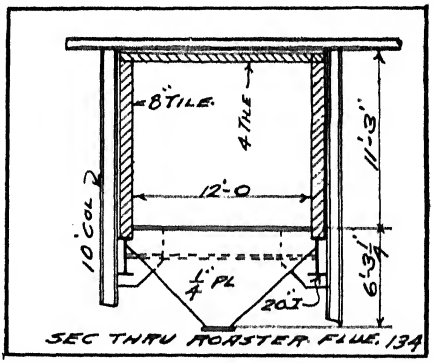
SEC. THRU. ROASTER D.C. 131



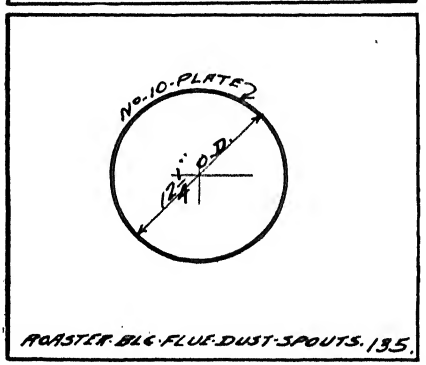
ROASTER FORMS FOR ARCH. 132



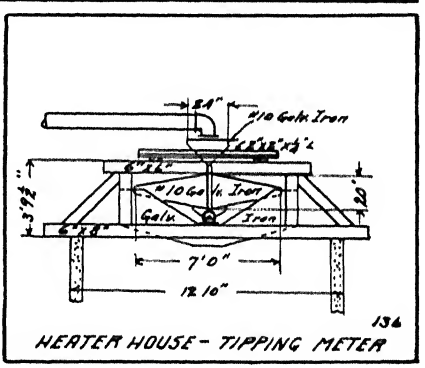
ROASTER PLAN OF FORMS ARCH. 133



SEC THRU ROASTER FLUE. 134



ROASTER BLG. FLUE DUST SPOUTS. 135



136

HEATER HOUSE - TIPPING METER

CHAPTER VI

DESCRIPTION OF COSTS

Engineering

Account 7100—Total Engineering Expense.

This account is a summation of accounts 7,101 to 7,206 inclusive, also of 9,000.1, power plant engineering expense. These accounts cover the engineering expenditures as their respective headings would indicate. As the total engineering expense they represent a percentage of the total cost of the smelter, less the engineering and indirect expenses, and have been so reported. In the making of any total estimate based on the unit costs derived from this sheet, it is assumed that of the total estimate so arrived at, 5.40 per cent. will be taken and added thereto to ascertain the item of engineering.

Account 7001—See Account 8999.
Account 7004—See Account 8999.
Account 7101—See Account 7100.
Account 7103—See Account 7100.
Account 7104—See Account 7100.
Account 7105—See Account 7100.
Account 7201—See Account 7100.
Account 7202—See Account 7100.
Account 7203—See Account 7100.
Account 7204—See Account 7100.
Account 7205—See Account 7100.
Account 7206—See Account 7100.

YARD TRACKS AND INDUSTRIAL SYSTEM

Tracks

Account 7301—Excavation.

This cost covers all of the excavating, barrow and grading incident to bringing the road beds of the New Smelter tracks to sub-grade. The materials worked varied from rock (Gila Conglomerate) through hard clayey soil filled with one-man stones, to light loam. The means employed to excavate covered the use of powder, plows, picks and shovels, slips and fresnos. The work covered by this cost was not carried on continuously, but as conditions about the plant permitted. The unit cost represents fairly the average cost of shallow excavating in large amounts about the smelter site.

Account 7302—Ties.

This account represents 700 steel ties, 7,656 white-oak ties laid in track, 524 white-oak ties in stock, 300 Oregon pine switch ties laid in track, and 1,082 white-oak ties used in temporary tracks and in handling machinery. There is also included here the labor of unloading, stocking, handling to points about the plant and placing upon the various grades. The steel ties are 7 ft. long, furnished with four No. 23 clips for 60-lb. A. S. C. E. rail, laid on 4 ft. 8½ in. gauge. They

were furnished by the Carnegie Steel Company and cost $1.66 each. (See Fig. 10.) The white-oak ties are rough hewn, 6 in. by 8 in. by 8 ft. and cost $1.05 apiece.

The switch ties were of Oregon pine, standard size and various lengths, according to their position in the track and the size of frog. They cost at the rate of $30.00 a thousand, board measure. The account thus stands as follows:

Labor	$425.13	
Wood ties	9,614.86	
Steel ties	1,162.93	
		$11,202.92

The average cost of each wood tie in the track represents $1.31. The ties were laid about 58 to the 100 ft. (See Fig. 10.)

Account 7303—Rails and Rail Fastenings.

The rails covered by this account were second hand, purchased from the Arizona and New Mexico Railway; 60 lb. A. S. C. E. standard. The track laid totaled 14,813 ft. long and was divided as follows:

On wood ties in dirt		On trestle	
Track No. 6	2,660 ft.	Track No. 7	294 ft.
7	1,023 ft.	15	403 ft.
8	1,940 ft.		
9	340 ft.	On steel ties	
10	645 ft.	Track No. 13	665 ft.
12	1,053 ft.		
13	1,396 ft.		
14	1,060 ft.		
15	1,685 ft.		
On wood ties in dirt		On steel ties	
Track No. 17	212 ft.	Track No. 14	283 ft.
18	279 ft.		
19	290 ft.		
24	585 ft.		

The account is divided up as follows:

29,626 ft., 60 lb. rail @ $27.50 a ton		$8,147.15
986 pr. angle bars @ $0.50		493.00
4,000 bolts @ $3.50 a hundred		140.00
4,000 nut locks $1.07 a hundred		42.00
95 kegs spikes @ $4.54		431.30
	$9,254.25	
Miscellaneous	585.54	
	$9,839.79	
Labor	392.00	

The miscellaneous item covers many second hand tie plates, short rail, material for extra angle bars made on the site, and a portion of temporary construction. The labor item represents handling, unloading and work on angle bars incident to different punching of rails.

Account 7304—Frogs and Switches

This item covers the cost laid in track of the following number of frogs purchased from the Cincinnati Frog and Switch Company:

9 No. 9 frogs with switches
7 No. 4 frogs with switches
2 No. 2¾ frogs with switches.

It also covers labor incident to replacing 4 or 5 old frogs laid previous to the arrival of the new material. Included with the old installation labor is the cost of making several new switch points.

Account 7305—Laying, Surfacing and Ballasting.

This account covers the laying of all tracks in the industrial system about the smelter and the ballasting of such tracks where ballasting was required. The total amount of track laid was 17,130 ft., of which 697 ft. was upon steel trestles.

The ballast used varied according to the conditions prevailing at the time. A large amount of the track was ballasted with material borrowed near the site, while other portions were ballasted with red oxide tailings from the leacher at the cost of $0.25 a yard, either dumped upon the track and spread with the use of the locomotive, or because of the excessive degree of track curvature for the locomotive, dumped and hauled to the place required.

The work of track laying and ballasting extended over many months, being prosecuted as the tracks were required for use, and in some cases as the steel arrived or ballast could be obtained. All tracks were standard gauge.

Trolley System

Account 7306—Poles and Setting.

This account covers the cost of stands, poles and ties to which the poles were attached as well as the labor incident to the erection of this work. There were 102 poles made of 4-in. pipe on an average of 16 ft. long set in a cast-iron stand 16 in. high. The accompanying sketches show four different conditions; double track with two poles used on the far sides of both tracks; double track one pole used between two tracks; single track and one pole and bracket on the under side of the slag track cut floor. (See Figs. 1, 2, 3 and 4.)

Account 7306.1—Brackets and Wiring.

This account covers all the material and labor incident to putting up the trolley line brackets, stringing the wire and insulating the work. The length of the trolley system is 7824 ft. of which 7,346 ft. is No. 000 H. D. grooved copper wire and 478 ft. of 25 lb. rail used through the slag track cut. The cost here has been figured on the lineal feet of system. Below is a list of the majority of items in the material account.

50 Insulator brackets similar to Ohio Brass Co. No. 1,254
200 Trolley brackets similar to Ohio Brass Co. No. 10,998
Six 15° frogs similar to Ohio Brass Co. No. 10,115
Six 15° frogs similar to Ohio Brass Co. No. 10,016
Three 15° frogs similar to Ohio Brass Co. No. 10,388

The messenger wire was $\frac{1}{4}$-in. strand extra soft galvanized steel strand. Extension arms were made of $1\frac{1}{2}$-in. pipe, 9 ft. long. One-quarter inch rod was used for arm brace. The voltage carried for the line is 230 D. C.

Account 7306.2—Rail Bonds.

This account covers cost of all material and labor incident to making the electrical bond throughout the trolley system. Each bond required the drilling of two $\frac{7}{8}$-in. holes through the web of the rails. For the most part it was necessary to remove and replace the angle bars. Five hundred twenty-one No. 000 cable rail bonds with $\frac{7}{8}$-in. hollow comp. studs, 1 ft. 11 in. center to center—see Fig. 5—type C. P. 2—A. S. & W. Co. furnished complete with drift pins. (See Fig. 5.)

Account 7306.30—Lighting.

This account covers the cost of all material and labor incident to lighting the trolley line. The electricity here used was taken direct from the trolley lines. Fifty-seven lamps—240 volt—120 watt carbon filament were installed. Four thousand feet of wire were used.

Rolling Stock

Account 7307—Cars, Electric Locomotives, etc.

This account covers the cost of the following equipment together with the labor of unloading, trying out, removing the air brakes from the slag cars which came in on their own wheels, installing extra controllers on slag cars, and a large amount of repair work not carried by account 7307.1.

	Factory Cost	Freight	Total
Three 18-ton calcine cars, weight of each including electrical equipment 33,200 lb. from Kilbourne & Jacobs Mfg. Co.....	$7,200.00	$1,394.22	$8,594.22
Four 225-cu. ft. capacity electrically operated slag cars, from M. H. Treadwell Co. Cars are side dumped by 15-h.p. motors; can also be dumped by hand. Weight of one car 57,000 lb.....	11,620.00	513.48	12,133.48
Two 18-ton electric locomotives from Westinghouse Mfg. Co. Draw-bar pull 8,000 lb. Each locomotive has two 84-h.p. motors. Weight of each locomotive is 43,950 lb.....	8,500.00	1,380.03	9,880.03
Weight of each locomotive is 43,950 lb...	8,500.00	1,380.03	9,880.03
One clinker larry car, 12½ tons capacity, 10-h.p. motor, weight 11,000 lb.....	1,450.00	176.00	1,626.00
Two trailer cars, 165 cu. ft. or 25,000 lb. capacity, weight of each car, 5,000 lb...	680.00	160.00	840.00
Two 15-h.p. 220-volt drum type controllers for electric locomotives to dump slag cars	.....	.....	165.64
One pair Schoen rolled steel wheels with axles for slag cars above.....	.....	.....	115.66
Miscellaneous material.....	.....	.....	662.60
			$34,017.63

(See Figs. 122, 123, 124, and 125.)

Account 7307.1—Calcine Car Alteration.

The calcine cars with their pantographs on top were too high to operate successfully beneath the roasters. To overcome this difficulty the tracks beneath were lowered 1 ft. and the cab end of the car was cut down 18 in. in height. The pantograph was then placed on the cab end of the car. Much difficulty was also experienced with the pantographs themselves, especially when the cars were on short curves and taking switches. This account covers all the labor and material incident to overcoming these difficulties.

Trestle Approach to Reverberatory Building

Account 7308—Excavation.

The ground excavated was cemented sand and gravel, overlain with soil permeated with caliche. All the work was done by hand, using picks and shovels. The excavated material was cast to the side of the pier holes, and in some cases it was handled three times.

Account 7308.1—Foundation.

The kind of foundation here represented is the pier type. Sixty piers were cast 5 ft. by 5 ft. by 8 ft. One large abutment was 26 ft. high,

including its footing. The mixture of concrete used was 7 parts of gravel and sand to 1 part of cement, mixed by hand and transported in wheelbarrows, an average of 80 ft. There was no reinforcing, but two anchor bolts, $\frac{7}{8}$ in. by 2 ft. long, were placed in every footing. About 70 per cent. of the concrete was formed. The pier tops were finished to a perfect elevation. This is true of all other foundations where they support steel columns.

Account 7308.2—Steel Structure.

This steel trestle was a part of a contract between the Arizona Copper Co. and the Kansas City Structural Steel Co. who furnished erected the major portion of the structural steel about the plant, at a ton price of $72.80 f.o.b. El Paso, and the corrugated iron at $81 f.o.b. Pittsburgh. In every case where a steel structure occurs in this cost sheet, an additional amount of money has been expended for a variety of purposes. A new unit price is therefore obtained which varies with the structure in question. The extra expenses entailed are the freight from Pittsburgh and El Paso, the lumber for nailing strips, air lines and power for riveting and erecting, extra trackage to deliver steel within required distance of erection site according to contract, and many smaller items rightly debited here. The unit figure therefore arrived at gives the actual cost of the steel structure as it stands in every case. There were 163.97 tons of structural steel used here.

Account 7308.3—Woodwork.

This account covers the labor and material for the ties, walkways and railing upon the steel trestle. In the case of the ties they were laid for large part upon 173-ft. radius curve and required dapping to accommodate a $\frac{1}{2}$-in. web projection of steel plate sticking up from each of the two girders which they spanned. The material used was as follows:

18,398 ft. b.m. 8 in. by 8 in. ties o.p.	$652.98
9,248 ft. b.m. 2 in. by 4 in.; 4 in. by 4 in.; and 2 in. by 12 in. 872 lb. $\frac{3}{4}$-in. round iron	21.37
Nails, bolts and miscellaneous	94.57
	$768.92

150 Ton Track Scales—Receiving Yard

Account 7309—Excavation.

The excavation was in tight sand and gravel. It was done with pick and shovel, handled into cars and hauled 500 ft.

Account 7309.1—Foundation.

This was a job of plain concrete mixed 8 parts sand and gravel to 1 part cement, hauled 2,000 ft. by teams and wheeled in barrows 50 ft.

to place. The concrete was principally walls with a few piers. Eighty per cent. of the exposed surface, other than top and bottom, was formed. A great many $\frac{3}{4}$-in. bolts were set in the concrete. (See Fig. 7.)

Account 7309.11—Cost and Erection.

This account covers the material and erection of one 50-ft., 150-ton suspension platform track scale with type-registering beam, graduated by 10 lb. The platform was arranged for two gauges of dead and live rails—4 ft. $8\frac{1}{2}$ in. and 3 ft. The scale was furnished by Fairbanks and Morse. The material portion of this account is divided up as follows: (See Fig. 7.)

	Cost	Freight	Total
One 50-ft. 150-ton suspension platform track scale	$1,351.00	$486.09	$1,837.09
294 rail clips	45.00		
75 stands and 72 rail blocks	211.85	77.36	362.91
Patterns for blocks and stands	28.70		
Structural steel for track scales			1,089.62
Twenty-five 10 by 12 6 ft. ties and 2 by 12 planks covering			55.83
Bolts, washers, round iron, nails, etc			105.41
			$3,450.86

Account 7309.30—Scale House.

This account covers the cost of material and erection of the scale house. The building in plan is 9 ft. 6 in. by 10 ft. with a shed roof. In front it is 10 ft. 6 in. high, and in the rear 8 ft. The studding is 2 in. by 4 in. and the rafters are 2 in. by 6 in. The siding is corrugated iron and on the roof is 1-in. sheething and composition roofing paper. There are two windows in both front and rear, and a door in each end. (See Fig. 8.)

Bridge No. 1

Account 7310.1—Foundation.

The concrete covered by this account consisted of two footings about 6 ft. by 6 ft. by 55 ft. with two abutments about 3 ft. by 14 ft. by 55 ft. at base to 14 ft. at top. It was plain concrete, 7 parts sand and gravel and 1 part cement, mixed by hand and by machine and wheeled 45 ft. to place. Ninety per cent. of the vertical and inclined surfaces were formed.

Account 7310.10—Bridge No. 1 Steel Work.

This work was covered by the Kansas City Structural Steel Co.'s contract. (See account 7308.20.) The bridge consisted of two girders—each of three 18-in. by 50-lb. by 20-ft. I-beams, connected with bolts and separators and anchored to the foundations with four 1-in. bolts.

Culvert No. 1

Account 7311—Culvert No. 1 Masonry.

This was a stone culvert 534 ft. long, with inside dimensions 4 ft. by 4 ft. The top was built of old 50-lb. rails at $15 a ton, spaced 8-in. centers and rendered tight with stones set with cement mortar in between rails. There is 20 ft. or more fill over the culvert at various points. The stones laid in cement mortar for the sides and bottom were obtained on the site.

Retaining Walls

Account 7312—Excavation.

This was a long narrow cut through fill, earth, and sand and gravel. It was taken out with picks and shovels and transported 200 ft. with slips.

Account 7312.1—Concrete.

The concrete covered by this account was a wall of gravity section, 8 in. at the top, of various heights and 80 ft. long. The mixture used was 7 parts sand and gravel to 1 part cement, wheeled 50 ft. Half of the yardage was hand mixed and half machine mixed.

Account 7312.20—Masonry.

This wall was built of stone which was gandy to the site and was laid in cement mortar. The wall was 124 ft. long, 12 in. to 18 in. thick and from 2 to 5 ft. high.

40-Ton Track Scales on Calcine Track

Account 7313—Excavation.

The excavation here covered was a small rectangular cut through tight, red soil, filled with large stones. It was picked, shoveled and wheeled in barrows 50 ft.

Account 7313.1—Foundation.

The concrete under this account was small walls about 30 ft. by 5 ft. by 22 in. and a 10-in. slab. It was mixed 7 parts sand and gravel to 1 cement by hand and wheeled 25 ft. to place. About twenty-six $\frac{3}{4}$-in. bolts were set in the concrete. Eighty-five per cent. of the vertical surface of this concrete was formed. (See Fig. 9.)

Account 7313.20—Cost and Erection.

This account covers the cost of the material and its erection of one 40-ton track scale. The scale platform is 24 ft. long with one 4-ft. $8\frac{1}{2}$-in. track passing over it. It has a type registering beam. The scales were furnished by Fairbanks Morse Co. Itemized, the material accounts stand as follows:

	Cost	Freight	Total
1 40-ton track scale complete	$400	$116.86	$516.86
6-in. by 6-in. ties; 8-in. by 12-in. stringers. 2-in by 12-in. decking			26.19
6-in. and 5-in. channels and 5-in. I-beams			102.85
Strap steel, bolts, pipe, hauling, etc			64.95
			$710.85

(See Fig. 9.)

Account 7313.30—Scale House.

Same as 7309.50—practically.

Trestles to Receiving Bins

Account 7314—Excavating.

This excavation covered two large abutments 6 ft. in the ground and 10 piers going about 15 ft. into the ground. The material excavated was earth and adobe. It was handled in the pier footings by a windlass.

Account 7314.1—Foundation.

The concrete here covered was in two large abutments and in 10 piers. The abutments were about 8 ft. by 16 ft. by 24 ft. and the piers 7 ft. by 7 ft. by 23 ft. Forty-eight $\frac{3}{4}$-in. bolts were set in the concrete. Twenty per cent. of the vertical surfaces were formed. The concrete was mixed in proportions of 7 parts sand and gravel to 1 part cement. A large amount of boulders were used in the piers. The concrete was both hand and machine mixed, and was wheeled in barrows an average of 200 ft.

Account 7314.2—Steel Structure.

There were 109.53 tons of structural steel used here.

Account 7314.30—Woodwork.

The woodwork here was practically the same in every respect as 7308.50, with additional walkways of 2 by 12 planks, nailed to strips bolted to the steel.

16,920 ft. b.m. 8 by 8 ties and 6 by 6 guard rails.

10,286 ft. b.m. 2 by 12, 2 by 4, 4 by 4 walk and 27,206 ft. total b.m. railings was used.

(See Fig. 6.)

Receiving Bins

Account 7401—Excavation.

This work covered the digging of a number of piers 7 ft. by 7 ft. to a depth ranging from 16 ft. to 25 ft. into gravel. The dirt was easily dug but had to be handled from the lower half of the holes with windlasses. It was carted away at the top 225 ft.

Account 7402—Foundation.

Only 5 per cent. of this concrete was formed. The lower part was machine mixed in proportions of 12 gravel and sand to 1 cement, while the upper part was 6 to 1. It was wheeled 200 ft. to place. The top surfaces were trowel finished to a perfect elevation for receiving the steel.

Account 7403—Steel Structure.

There were 11.35 tons of corrugated and 341.74 tons of structural steel used here. (See account 7308.2. See Fig. 11.)

Account 7404—Gates.

This account covers the cost of material, unloading hauling, fabrication, alteration, and erection of 30 gates beneath the receiving bins. All cast-iron parts together with operating wheel, shaft and gate itself were purchased outright.

The chutes attached to the gates were fabricated in the new smelter shops. The parts were assembled in the field and there erected. The holes in the steel structure to which the gates were attached had to be rebored in the field. The counterweights for the 12 coarse ore-bin gates were made on the job and erected. These 12 counterweighted gates are opened by rack and pinion, operated by a hand wheel and cut up through the stream. The chutes to guide the ore to the feeder are of $\frac{3}{8}$-in. plate, while the gate is $\frac{5}{8}$ in. The other 16 gates for the concentrate bin are similar to the above, but are not counterweighted and cut down through the stream. (See Fig. 12.)

Account 7405—Conveyor No. 1.

This account covers the entire labor and material connected with the installation of conveyor No. 1. It does not include the steel frame to which the idlers are attached, but does cover the cost and installation of the traveling feeder with the necessary ties, rails, wire and motor. This segregation of charges is true of all conveyor costs given in this Cost Sheet. All the conveyors were furnished by the Robins Conveying Belt Co. Conveyor No. 1 was a 30-in. belt, making a 97-ft. conveyor with a 3-ft. rise, operating at a speed of 150 ft. per minute, capable of handling 100 tons per hour. It is supplied with 12-in. material from the bins above it through a speeded feeder. (See Fig. 6.) The material account is segregated as follows:

	Cost	Freight	Total
202-ft. 30-in. belt	$686.80	$46.45	.....
Feeder belt	56.75	.....	.....
Conveying idlers, etc	1,497.12	185.09	.....
Cent. switch	34.00	2.20	.....
Broken pulley	44.00	.....	.....
Miscellaneous material	307.73	.....	.....
One 5-h.p. motor	87.05	.....	.....
	$2,713.45	$233.74	$2,947.19

Account 7406.01—Conveyor No. 22.

This conveyor is similar to No. 1. It has a 20-in. belt, making a conveyor 117 ft. long, with a 3-ft. rise, operating at a speed of 200 feet per minute with a capacity of 150 tons and taking $\frac{3}{8}$-in. concentrates through a speeded feeder. The material account is segregated as follows:

	Cost	Freight	Total
241-ft. 6-in. to 20-in. belt	$432.38	$31.94	
Feeder belt	56.75		
Robins material	1,367.50	169.07	
Cent. switch	34.00	2.21	
Miscellaneous material	317.14		
5-h.p. motor	87.04		
	$2,294.81	$203.22	$2,498.03

(See Fig. 13.)

Account 7407—Lighting.

The receiving bins were lighted with 22 drop lights using 100 volts A. C. current.

Crushing Plant

Account 7701—Excavation.

This was a large rectangular cut for the Crusher Building made through cemented sand and gravel, with streaks of soil running through the cut hardened by caliche. The work was done with pick and shovel and handled by wheelbarrow into carts and hauled 225 ft.

Account 7702—Foundation.

This concrete was reinforced with $\frac{1}{2}$-in. and $\frac{3}{4}$-in. round, medium steel rods. It was cast in walls, 12 in. thick, about 12 ft. high and as a 12-in. floor slab. The concrete was machine mixed in the proportions of 5 sand and gravel to 1 cement and about 60 per cent. of the vertical surfaces were formed. It was wheeled in barrows 400 ft. up an 8 per cent. grade.

Account 7703—Steel Structure.

There were 5.17 tons of corrugated iron and 19.90 tons of structural steel used. (See account 7308.2.)

Account 7703.1—Doors, Windows and Frames.

The material here used for openings was as follows:

9 windows and frames 3 ft. $10\frac{5}{8}$ in. by 7 ft. 8 in., 24 lights. 4 sash and frames, 2 ft. $11\frac{1}{4}$ in. by 3 ft. $11\frac{1}{4}$ in., 9 lights.	$138.40
Balance, butts, catches, etc	25.38
Lumber for sills	6.93
	$170.71

Account 7703.2—Painting Woodwork.

All the woodwork was painted with two coats of lead and linseed oil in cream color.

Account 7704—Crushing Machinery.

This account covers the material cost and labor of installing the following machinery:

One 36-in. by 18-in. Farrell Crusher, second hand, weight 50,000 lb	$1,000.00
Miscellaneous lumber	93.61
	$1,093.61

Account 7704.1—Chutes.

This account covers the cost of material noted below, the labor of fabricating the spouts, hoppers, and their erection:

1 Grizzly screen 3 ft. by 8 ft. made of 1-in. bars, having 2½-in. by 2½-in. openings, framework made of $\frac{3}{16}$-in. plate and 3-in. by 3-in. angles.

1 Spout for grizzly, dumping on conveyor No. 4 made of $\frac{3}{16}$-in. steel plate and 2-in. by 2-in. by ¼-in. angles. ¾-in. C.I. liners used.

1 Hopper for crusher made of $\frac{3}{16}$-in. steel plates 2½-in. by 2½-in. by ⅜-in. angles. ¾-in. C.I. liners used.

Account 7705—Shafting, Pulleys and Belting.

This account covers the material cost and erection of the following:

1 Pc. shafting 4 $\frac{7}{16}$ in. by 6 ft. 6 in. with two collars	$29.64
1 Pc. shafting 4 $\frac{7}{16}$ by 5 ft. 3 in	16.51
Two 4 $\frac{7}{16}$-in. rigid pillow blocks	58.55
One 48-in. by 11-in. split pulley	47.59
One 36-in. by 16-in. split pulley	43.71
Two 4 $\frac{7}{16}$-in. safety collars	5.39
43 ft. 10-in. two-ply leather belt	60.80
42 ft. 14-in. two-ply leather belt	220.37
Miscellaneous	0.79
	$483.35

Account 7706—Motor.

This account covers the cost of the following material and the installation:

One 50-h.p. Crocker-Wheeler squirrel-cage motor with starter	$478.41
Lumber for housing motor	35.23
	$513.64

Account 7707—Power Wiring.

Account 7707.1—Lighting.

This account covers the cost and installation of the following material:

8 drops 16 candle power
30 ft. brewery cord
350 ft. No. 12 weatherproof wire
45 ft. 1-in. conduit.
Switches, bolts, etc.

Sampling Plant

Account 7801—Excavation.

This account covers the excavation of the sampling plant and the necessary backfill tamped in 5-in. layers in the low parts where the basement concrete floor was cast. It was done with picks, shovels and wheelbarrows, through earth, sand and gravel.

Account 7802—Foundation.

This concrete was cast in the walls and piers of the sampling plant. It was mixed by machine in the proportions of 7 parts sand and gravel to 1 part cement and wheeled in barrows 150 ft. Ninety per cent. of the vertical surfaces of the concrete was formed. The cost of all anchor bolts as well as the finish to exact level for building columns is included here.

Account 7802.1—Concrete Ground Floor.

This was plain concrete floor laid with sand joints in about 6-ft. square blocks 5 in. thick, in the proportions of 5 parts sand and gravel to 1 cement. The top finish was 1 in. thick, made 2 parts sand to 1 cement, troweled smooth. The concrete was mixed by machine and transported 175 ft. in barrows.

Account 7802.2—Reinforced Concrete Floors.

This concrete was cast over steel I-beams, using forms between the steel beams. The mix was the same as the above floor with the same top finish. The reinforcing used was Clinton welded fabric 2-in. by 12-in. mesh. The floor was $4\frac{1}{2}$ in. thick. The concrete was mixed by machine and transported 500 ft. to place by wagon, wheelbarrow and hoist.

Account 7803—Steel Structure.

There were 13.46 tons of corrugated iron and 97.39 tons of structural steel used. (See account 7308.2.)

Account 7803.1—Doors, Windows and Frames.

This account covers the purchase price and erection cost of material enumerated below. The doors are not given in the list, as they were made upon the job, but correspond to the frames noted. Necessary hardware is also included in the cost.

Fourteen 24-light windows 3 ft. $9\frac{1}{4}$ in. by 7 ft. 8 in. by $1\frac{3}{8}$ in. with frames

Twenty-nine 40-light windows 7 ft. $5\frac{3}{4}$ in. by 3 ft. $10\frac{5}{8}$ in. by $1\frac{3}{8}$-in. with frames

Two 9-light windows 2 ft. 11¼ in. by 3 ft. 11¾ in. by 1⅜ in. with frames	
One 4-ft. 8-in. by 7-ft. 4-in. door frame	
One 9-ft. 2-in. by 8-ft. 10-in. door frame	
Three 4-ft. 8-in. by 7-ft. 4-in. door frames	
Five 3-ft. 8-in. by 7-ft. 4-in. door frames	
One 3-ft. 8-in. by 7-ft. 2-in. door frame	
One 9-ft. 2-in. by 9-ft. 2⅝-in. door frame	$564.90

(See Fig. 14.)

Account 7803.11—Painting Doors and Windows.

This covers the material and labor of applying two coats of linseed oil and white lead.

Account 7804—Shafting, Pulleys and Belting.

This is not a good cost. The labor is unquestionably too low and has been absorbed by some of the following accounts up to account 7807.5. Eighty-five feet of shafting, varying in size from 1 15/16 in. to 3 7/16 in. with 28 pulleys of various diameters and face with the various hangers, collars, etc., and 1,325 ft. of 3-in. to 12-in. leather belting were to be taken care of here. The material is correct. (See Fig. 108.)

Account 7805—Motors.

The material covered by this account is as follows:

One 15-h.p. squirrel-cage motor	$189.94
One 75-h.p. slip ring	644.00
Overload release	14.25
Miscellaneous	39.38
	$887.57

Account 7806—Power Wiring.

Account 7806.1—Lighting.

36 drop lights	
No. 12 weatherproof wire used in conduit	$140.57

Account 7807—Rolls and Samplers, Cost and Erection.

This cost covers the price and installation of the following material, together with the application of two coats of Dixon's Silica Graphite paint upon the Rolls, Samplers and Chutes:

	Cost	Freight	Total
2 sets 24 by 12 rolls, from Chalmers and Williams	$1,330.00	$344.16	$1,674.16
1 set 42 by 16 rolls, from Chalmers and Williams	1,567.50	482.40	2,049.90
1 set 48 by 12 rolls, from Chalmers and Williams	1,710.00	716.43	2,426.43
One 27-in. Snyder sampler with 28-in. by 3½-in. pulley T. & L.	38.00	5.04	43.04

	Cost	Freight	Total
Two 42-in. Snyder samplers with 40-in. by 3½-in. pulley T. & L.....	133.00	29.95	162.95
1 No. 1 Vezin sampler with spout arranged for 5 per cent. cut, Allis-Chalmers.....	162.00	20.51	182.51
1 No. 3 Vezin sampler with spout arranged for 10 per cent. cut, Allis-Chalmers.....	220.00	45.64	265.64

	Cost	Freight	Total
Two 5-T steel plate crawls for 12-in. I's...	$104.00	$15.76	$119.76
One 4-T steel plate crawls for 10-in. I's...	40.00	6.11	46.11
Two 3-T steel plate crawls for 9-in. I's....	64.00	8.61	72.61
One 5-T Triplex chain block	112.00	14.49	126.49
One 4-T Triplex chain block.....	88.00	9.10	97.10
Structural steel, machine parts.....	.....	.....	632.44
Miscellaneous, etc.....			$7,899.14

(See Figs. 15, 16, 110, 111 and 112.)

Account 7807.10—Cast Iron Liners and Drying Pan, and Erection of Chutes.

This account covers the erection of account 7807.5, and the cost and erection of the following:

1 Sample drying pan 8 ft. ½ in. by 5 ft. 2½ in.....	$136.11
¾-in. C.I. liners for chutes, castings c.....	865.75
	$1,001.86

Account 7807.20—Elevators.

Below is a description of the elevator with the material cost. The erection is too low and not usable.

33 ft. between head and tail shafts
Head and tail pulley 34 in. by 9 in.
Drive pulley 23 in. by 6 in., 40 h.p.m.
All housed with No. 10 plate steel casing
72 ft. 6 in. of 8-in. 6-ply rubber belt
Forty-eight 6-in. by 4-in. malleable buckets, style A.A. Mfrs. std.
Liners for casing made of white iron ¾ in. and 1 in. thick
Cost..... $458.22
(See Fig. 11.)

Account 7807.5—Steel Chutes.

This is the average cost per pound of material and labor for fabricating all steel chutes used in the sample mill. In general they were made of $\frac{3}{16}$-in. plate and light angles. The cost of erecting is in 7807.1 and in the comparative costs are found the individual chute costs. (See Fig. 109.)

Account 7809—Keystone Plate Partitions.

1,523 sq. ft. of No. 14 Keystone Plate partitions were erected by riveting the plates together and attaching them to the structural steel of the building. The plates were orginally intended for a roof upon the Roaster Dust Chamber and had each long edge turned up $1\frac{1}{2}$ in. The cost of cutting these edges off is here included. (See Fig. 113.)

Account 7810—Alteration of Chutes and Machinery.

Bedding Plant and Bunker Bins

Account 7901—Excavation.

This excavation involved making long, deep, oblong cuts through earth and sand and gravel bonded with caliche. It was necessary to use power to shake up the ground, followed in some cases with plows. A part of the work was handled with slips and fresnos; another part by picks, shovels and wagons. The average haul was 600 ft.

Account 7902—Foundation.

This concrete yardage was made up as follows:

550 ft. footing, 4 ft. wide by 2 ft. deep-plain
550 ft. wall, 1 ft. 6 in. thick by 5 ft. high-plain
1200 ft. footing, 3 ft. 6 in. wide by 10 in. deep-plain
600 ft. wall, 1 ft. 6 in. thick by 6 ft. high-plain reinforced coping
600 ft. wall, 1 ft. 6 in. thick by 11 ft. high-plain
320 ft. footing, 7 ft. wide by 3 ft. deep, reinforced with $\frac{3}{4}$-in. and $\frac{1}{2}$-in. rods, 6 in. on centers
320 ft. wall, 4 ft. 5 in. thick by 11 ft. high, reinforced with $\frac{3}{4}$-in. rods, 12 in. on centers
12,700 sq. ft. rough finished slab, 5 in. thick

The concrete, of which 85 per cent. of the vertical surface was formed, was machine mixed, in the proportions of 7 parts sand and gravel to 1 part cement. It was wheeled to place in barrows, a distance on the average of 180 ft. About half of the yardage was reinforced.

Account 7903—Steel Structure. (See account 7308.2.)

Structural steel	510.41	tons
Corrugated iron	38.30	tons
	548.71	tons

(See Fig. 114.)

Account 7904—Conveyors 7^1, 7^2. (See account 7405, and Fig. 91.)

Conveyor 7^1 has a 20-in. belt, 180 ft. 3 in. from center line to center line of head and tail pulleys with an 8-ft. 9-in. rise, operating at a speed of 300 feet per minute, with a capacity of 150 tons per hour. It takes $\frac{3}{8}$-in. material which it unloads through a 20-in. automatic tripper. It brings the fines from the Conveyor 5 to the bedding conveyors. Conveyor 7^2 has a 20 in. belt, 200 ft. long from center line to center line of head and tail pulleys with a 9-ft. 2-in. rise, operating at a speed of 400 feet per minute, capable of handling 100 tons per hour. It takes $2\frac{1}{2}$-in. material from Conveyor 6 which it unloads through an automatic tripper into the Bunker Bins beneath. The original installation here called for a bedding tripper at $950, which was superseded by an automatic tripper. Both charges are in this account. For a proper unit cost here, this charge of $950 should be deducted.

The woodwork noted below in the segregated charges includes walkways of two 2 by 12's beside both conveyors, as well as decking.

	Cost	Freight	Total
Belts	$1,433.79	$102.35	$1,536.14
Conveyor material	1,451.06	.....	.....
2 automatic trippers and track (used)	1,228.38	369.02	3,998.46
1 ore bedding tripper (discarded)	950.00	.....	.....
Lumber			253.74
$7\frac{1}{2}$-h.p. motor conveyor 7^1			138.75
10-h.p. motor conveyor 7^2			156.80
Centrifugal switch			72.40
Drive Belts			54.80
Wire for motors			97.26
Painting material			20.88
Miscellaneous			44.44
Total			$6,373.67

Account 7904.1—Conveyors 8^1, 8^2, 8^3.

(See account 7405.)

Conveyors 8^1, 8^2, 8^3 are practically identical, running out over the three beds. The exception is that conveyor 8^3 has a 6-ft. in place of a 3-ft. rise at the start and is 5 ft. longer. In general the three belts are 20 in. wide, 186 ft. 9 in. long, from center line to center line of head and tail pulleys, with a 3-ft. rise, operating at a speed of 400 ft. per minute, with a capacity of 150 tons per hour, taking a $\frac{3}{8}$-in. material and distributing it through a bedding tripper onto the beds below. This account segregated shows as follows:

	Cost	Freight	Total
Belts	$2,124.73	$152.34	$2,277.07
Conveyer material	1,793.55	.....	.....
3 ore bedding trippers	2,850.00	569.53	5,213.08
Lumber, walkways, decking			237.13
Three 15-h.p. motors			569.82
Centrifugal switch			108.60
Drive belts			72.41
Electrical supplies			145.89
Painting material			31.32
Miscellaneous			63.66
Total			8,718.98

(See Fig. 91.)

Account 7904.2—Conveyors 9^1, 9^2, 9^3, 10^1, 10^2.

(See account 7405.)

All these conveyors are on wooden supports, the material for which and the cost of walkways is here included.

Conveyors 9^1, 9^2, 9^3 are identical. They take the reclaimed material from the beds to conveyor 10^1. They are 20-in. wide belts, 198 ft. 4 in. from center line of head pulley to center line of tail pulley perfectly flat, operating at a speed of 300 feet per minute, with a capacity of 100 tons per hour.

Conveyor 10^1 takes the material from 9^1, 9^2, 9^3 to conveyor 11. It is 145 ft. 3 in. from center line of head pulley to center line of tail pulley, perfectly flat, operating at a speed of 300 feet per minute, with a capacity of 100 tons per hour.

Conveyor 10^2 takes the material from the Bunker Bin gates to Conveyor 14. It has a 20-in. belt, is 165 ft. long from center line of head pulley to center line of tail pulley, is perfectly flat, operating at a speed of 300 feet per minute, with a capacity of 100 tons per hour. It uses one feeder below the gates the same as on Conveyor 2.

The material segregated is as follows:

	Cost	Freight	Total
Belt	$3,300.76	$228.98	$3,529.74
Feeder belt on 10^2	.....	.....	56.76
Conveyor material	2,718.25	.....	.....
Feeder conveyor 10^2	925.00	586.43	4,229.68
Lumber for walkways, decking, framework, etc			755.61
5 overload releases			71.25
5 centrifugal switches			181.05
Five 5-h.p. motors			435.20
Drive belts			106.28
Electrical supplies			243.13
Painting material			52.19
Miscellaneous			95.30
Total			$9,756.19

(See Fig. 115.)

Account 7904.3—Bunker Bin Gates.

These are cast-iron chutes about 22 in. square with an arc gate controlling the discharge through the bottom. All cast iron is $\frac{3}{4}$-in. thick, save the $\frac{5}{8}$-in. wearing plate upon the arc gate. The operating lever was furnished in the structural steel contract.

42 spouts $\frac{3}{4}$-in. cast iron 42 gates $\frac{3}{4}$-in. cast iron 42 cover plates $\frac{5}{8}$-in. cast iron	$1,021.64

Account 7904.4—Chutes for Conveyors 7[1] to 10[2] inc.

This account covers the fabrication, erecting and material in the chutes directing the ore from one belt to another at the Beds and Bunker Bins. Also included here are the cast-iron wearing plates for lining the Chutes.

The chutes are made of $\frac{3}{16}$-in. plate and the necessary angles. The wearing plates are $\frac{3}{4}$ in. to 1 in. thick, hard, white cast iron.

Account 7905—Two Reclaimers.

(See Fig. 116.)

Account 7905.1—Two Reclaimers Wiring.

This account covers the material cost and labor of installing a double trolley wire on three beds together with the wiring of two reclaimers and switchboards. The material is wire, condulets, circuit breakers, and the like. (See Fig. 118.)

Account 7906—Lighting.

This account covers the labor and material used in lighting the Bedding Plant and Bunker Bins.

63 carbon lamps, 16 candle power
455 ft. brewery cord
1,395 ft. No. 8 weatherproof wire
1,835 ft. No. 12 weatherproof wire
205 ft. $1\frac{1}{2}$-in. conduit
285 ft. 1-in. conduit.

Account 7907—Transfer Car.

This car was a structural steel frame about 4 ft. high and 62 ft. by 18 ft. in plan. It transfers the Reclaimers from one bed to another, or to the repair shed under its own power, using a $7\frac{1}{2}$-h.p. motor, getting direct current through a trolley. It was furnished by the Robins Conveying Belt Co. (See Fig. 117.)

Account 7908—Signal System.

This account is of no value.

Roasting Plant

Account 8101—Excavation.

This covered a large surface grade made to the required elevation of the site, made by plows and fresnos and hauling the dirt to a railroad grade an average of 450 ft. This was followed by picks, shovels and carts, making deep cuts to gravel through red clay and boulders for the steel foundation.

Account 8102—Foundations.

This concrete was all cast as piers with at least $2\frac{3}{4}$-in. bolts in each pier. Only 10 per cent. of the vertical surfaces was formed, though many of the piers were 6 ft. deep. One-half of the concrete was machine mixed and one-half was hand mixed in the proportions of 7 parts sand and gravel to 1 cement. The pier tops were finished to a perfect elevation to receive the steel columns. The concrete was wheeled about 60 ft.

Account 8103—Steel Structure.

(See account 7308.2.)

There were 23.16 tons of corrugated iron and 422.12 tons of structural steel used. (See Figs. 117 and 118.)

Account 8103.1—Elevator.

This account gives the entire labor and material incident to erecting a 52-ft. high 10-ft. 6-in. by 8-ft. 6-in. platform elevator in a self-supporting structural steel frame. It does not include other than the excavation and concrete pit. The account segregated stands thus:

Structural steel erected for elevator frame and tower	$840.97
One 5-T electric hoist with 240-volt D.C. motor	1,261.60
3,792 b.f. lumber	11.56
Rope sheaves, counterweights, etc	29.23
Labor	37.79
Miscellaneous	8.47
	$2,189.62

The labor installed the motor, hoist and wood platform.

Account 8104—Roasters, Cost and Erection.

This account covers the cost and erection of the roaster shells as furnished by the Kansas City Structural Steel Co. and the roaster equipment, namely, the central shaft, rabble arms, rabbles, driving mechanism, doors to roasters, cast-iron rings, etc. As segregated the material account shows below. The Herreshoff furnaces have 6 superimposed hearths and a top drying hearth. The arms are cooled by air furnished by two motor-driven fans. The diameter of the shell is 21 ft. $7\frac{1}{4}$ in. outside and 18 ft. 2 in. in height.

	Cost	Freight	Total
8 furnaces from Pacific Foundry Co. designed by Gen. Chemical Co.	$36,278.12	$8,016.73	$44,294.85
Eight 1-ton steel trolleys for 6-in. I's (See Fig. 121.)	.....	.....	155.30
One 1-ton duplex chain block	.....	.....	27.47
Steel shells erected—KCSSCo	10,192.73	840.06	11,032.79
Power for riveting	.....	.....	452.25
Miscellaneous	.....	.....	363.43
			$56,326.09

Account 8104.1—Roaster Alteration.

Account 8105—Brickwork.

This account covers the cost of the brick, mortar materials, etc., and labor of the mason with helpers of installing the brick in the roasters. The unloading of the brick from cars, the centers and carpenter labor are taken care of elsewhere. The brick here used were in the main special shapes and 95 per cent. of them were hard burned red brick. In all there were 15 different shapes. The hearths were laid dry and the shell brick laid with slimes from the copper company's concentrator. (See Fig. 133.)

Account 8105.01—Brick Unloading.

This covers the cost of leveling ground, checking up quantities, and unloading of brick from cars to roasters. This total cost includes the unloading of all brick for roaster use, the actual amount needed plus the extra not used.

Account 8105.02—Brickwork Centering.

This account covers the cost of making, installing, removing and the material for 16 sets of centers used for putting in 48 hearths. (See Fig. 133.)

Account 8106.01—Roaster Flue-spouts.

This covers the cost of material and erection of 10 spouts with gates from the roasters' common flue. The material is as follows:

10 cast-iron gates for 12¼ in. diameter spouts.

10 spouts of No. 10 plate, 24 ft. long, 12¼ in. outside diameter fastened to base of hopper by 2 in. by 2 in. angle collar.

10⅜ in. plate slides for gates.

(See Fig. 135.)

Account 8106.02—Tile Work.

This account covers the mason labor, carpenter labor, cost of tile and unloading, mortar materials and a lumber charge for scaffolds used in this flue. The flue is built of tile and is about 50 ft. from the ground. The tile for the roof was laid between T iron spanners from wall to wall. The mortar was lime. (See Fig. 132.)

Account 8106.03—Painting Flue.

The inside of the above flue was given one coat of silicate of soda. The account covers this material and labor cost.

Account 8107—Shafting, Pulleys and Belting.

Below is the material list erected under this account. The shafting was attached directly to the steel frame of the building.

47 ft. of $3\frac{3}{16}$-in. shafting 103 ft. of $2\frac{15}{16}$-in. shafting Two 20-in. by 12-in. pulleys One 36-in. by 10-in. with clutches for each Roaster	.....	$1,500.50
150 ft. 10-in. 6-ply rubber belt 310 ft. 8-in. 7-ply rubber belt	.....	471.85
Miscellaneous		27.54
		$1,999.89

Account 8108—Motor.

This covers the cost of material and labor of installing one 30-h.p. motor to drive the Roasters. It is located directly upon the first steel floor of the Roaster Building.

One 30-h.p. squirrel-cage motor	$267.80
One overload release	14.25
Miscellaneous wire, insulators, belt, etc.	181.91
	$463.96

Account 8109—Lighting.

The Roasters are furnished with light on all floors.

Account 8112—Motor-driven Fans.

This covers the price and cost of installing upon their foundations 2 motor-driven fans, which furnish the air to cool the roaster arms. They are 55-in. double width, full housing conoidal fans, direct connected, each with a 25-h.p. squirrel-cage induction motor.

Each fan has a capacity of 22,000 cu. ft. of air per minute against a pressure of $1\frac{3}{4}$ in. water.

	Cost	Freight	Total
2 fans and motors	$1,203.00	$199.49	$1,402.49
Miscellaneous			3.42
			$1,405.91

Account 8112.1—Blast Pipe.

This account covers the material price, cost of fabrication and installation of 240 ft. of blast pipe. The installation referred to is connecting up and riveting the pipe in place in the field only. The pipe is made of No. 10 and No. 12 plate and varied in diameter from 18 in. to 36 in. The inlet pipe to each roaster was 18-in. diameter.

Account 8113—Conveyor No. 12.

See account 7405. This conveyor takes the material of the beds from conveyor No. 11 and delivers it to conveyor 13^1 and 13^2. It is a 20-in. belt, 51 ft. 3 in. from center line of tail pulley to center line of head pulley, with an 8-ft. rise, operating at a speed of 300 ft. per minute, with a capacity of 100 tons per hour. The segregated material account is as follows:

	Cost	Freight	Total
Belt	$209.43	$14.43	$223.86
Conveyor material	370.91	45.86	416.77
One 5-h.p.m.	.....	.....	87.04
1 centrifugal switch	34.00	2.21	36.21
Lumber, decking and painting material			30.97
Spout conv. 11 to conv. 12			7.70
Miscellaneous			2.50
			$805.05

Account 8113.1—Conveyors 13^1 and 13^2.

Conveyors 13^1 and 13^2 take the product from conveyor 12 running the length of the Roaster Building each delivers the material through a separate automatic tripper to the roaster bins. They are identical. Both are 20-in. belts, running perfectly flat, 109 ft. from center line of head pulley to center line of tail pulley, operating at a speed of 300 ft. per minute, with a capacity of 100 tons per hour. The account for material stands as follows:

	Cost	Freight	Total
Belt	$837.72	$59.26	$896.98
Conveyor material	913.60	236.45	2,150.05
2 automatic trippers & track	1,000.00	.....	.....
Two 5-h.p. motors	.....	.....	174.08
2 centrifugal switches	68.00	4.42	72.42
Drive belt			30.79
Lumber, decking, paint			123.90
Spouts from conveyor 12			11.54
Miscellaneous			12.57
			$3,472.33

(See Fig. 91.)

Account 8113.2—Stile over Conveyors 13^1 and 13^2.

These stiles were made of structural steel, purchased from the Kansas City Structural Steel Co. and erected by the Arizona Copper Co.

Roaster Dust Chamber

Account 8121—Excavation.

Same as 8101.

Account 8122—Foundation.

Same as 8102.

Account 8123—Steel Structure.

See account 7308.2.

There were 14.8 tons of corrugated iron, 376.4 tons of structural steel used here and 27.63 tons of No. 11 Keystone plate. (See Figs. 103 and 131.)

Account 8123.01—Wire Baffles.

This account covers the cost of material, labor, and repairs entailed in installing 60,480 wire baffles in the roaster dust chamber. The wires with hooks on one end like shepherds crooks were hung 4 in. on centers both ways from chains supported from the lower members of the roof trusses 4 in. apart. The segregation of material is as follows. The wires hung a few inches off the dust chamber bottom and were thus of various lengths. (See Fig. 131.)

1,008 ⅜-in. chains 20 ft. 6 in. long with two hooks	$1,451.00
63,964 lb. No. 10 wire (black)	2,877.82
6,557 lb. No. 10 wire (black)	361.96
Miscellaneous	67.35
	$4,758.23

(See Fig. 131.)

Account 8123.1—Tile Work.

The sides of the roaster dust chamber and inclined bottom were built of 4-in. hollow tile. This material, labor of masons and their helpers, lumber for scaffolds, carpenter labor, mortar, material and power for hoisting are here included in the cost.

Account 8123.11—Tile Unloading.

This account covers the cost of unloading, wheeling, checking quantites and leveling up ground to receive tile.

Account 8123.2—Painting Outside.

The outside of the tile portion of the chamber, namely, sides and bottom, were given one coat of mineral red and linseed oil. The mortar was scraped from the tile before applying. This account covers the labor and material.

Account 8123.3—Painting Inside.

The tile work on the inside of the dust chamber was given one coat of silicate of soda used as a paint. This account covers the labor and material of this operation.

Reverberatory Plant

Account 8301—Excavation.

This was the making of a deep surface cut for the building. The material was principally red clay and boulders. In many cases power was used. In general the ground was plowed, scraped with fresnos through a trap into narrow-gauge side-dump cars and hauled, 2,000 ft. by steam locomotive to make a railroad fill.

Account 8301.01—Backfilling.

This covers the cost of backfilling in the reverberatory bottoms and between the reverberatories. The dirt was red clay soil. It was plowed, hauled in wagons, dumped, shoveled into a derrick box and lifted by a locomotive crane over the reverberatory sites and dumped. It was then distributed with wheelbarrows and tamped in 4-in. layers.

Account 8302—Foundation.

This work consisted of long walls averaging 230 ft. long 4 ft. at top and 6 ft. at bottom, and of beams to withstand the reverberatory buck stay pressure, averaging 660 ft. long by 3 ft. by 3 ft. The walls were reinforced with $\frac{3}{4}$-in. rods, spaces about 4 to 6 in. on centers, while the beams were reinforced with $\frac{3}{4}$-in. and 1-in. rods about 4 in. center lines one way.

The mixture used was 1 part cement and 5 parts sand and gravel, machine mixed, transported 100 ft. average, with wagons, cars, wheelbarrows and concrete carts as the situation demanded. 100 per cent. of the vertical surface was formed.

Account 8302.1—Concrete Counterweights.

These are used for the cross and header flues. Some are 1 ft. square from 6 ft. to 10 ft. long, cast in wooden forms. Others are circular, cast in steel cylinders. The concrete was mixed in a machine, wheeled 150 ft. and made plain with 1 part cement to 5 sand and gravel.

Account 8303—Steel Structure.

There is in this building 55.31 tons of corrugated iron, and 405.78 tons of structural steel.

Account 8304.—Reverberatories—Brickwork.

This account covers all the brick, mortar material and mason labor used in laying the brick of three reverberatories. The overall dimensions of the furnaces are 104 ft. long by 27 ft. wide and about 10 ft. 6 in. to the crown of the arch. The side walls are 2 ft. 6 in. thick and the arch is 20 in. deep. In the three reverberatories there was used 106,350 red brick, laid in lime mortar and 257,288 various shaped silica brick dipped in silica slimes. (See Figs. 77, 78 and 79).

Account 8304.01—Unloading Brick.

This account covers the cost of preparing the unloading site, building three brick sheds of 84,000 cu. ft. capacity, the unloading of the brick, checking the quantities, and piling separately 31 different shapes.

Account 8304.02—Centering.

This account covers the cost of material, fabrication of one center together with the labor and erecting and tearing it down three times. The arch was made of 2 by 12 centers with 1-in. sheathing tacked on top. The 2 by 12 centers were spaced 18 in. centers, supported on 6 by 8 stringers held up by 4 by 8 posts suitably braced. (See Fig. 130.)

Account 8304.05—Rehandling Brick.

This account covers the transporting at many different times of the silica brick from the sheds to the reverberatories a distance of 500 ft. by one-mule carts.

Account 8304.1—Steel Work.

This account covers the cost of the material and labor of installing the steel buck stays for the reverberatories. Below is a list of material:

Buck stays	276 12-in. 31.5-lb. beams on sides
Buck stays	84 12-in. 31.5-lb. beams on ends
Rails	1,212-ft. 60-lb. rails
Rails	594-ft. 75-lb. rails
Cross stay rds.	78 $1\frac{5}{8}$ in. diam. 31 ft. 8 in. long
Longitudinal rds.	27 $1\frac{3}{4}$ in. diam. 110 ft.

6 steel supports for longitudinal rods made of 2 to 8-in. angles $11\frac{1}{4}$ lb. (See Fig. 78.)

Account 8304.2—Silica Fill.

This cost is for the silica purchased, crushed in a variety of ways, transported to the furnaces and tamped in place there in layers. It came from the Calumet and Arizona Mining Co., at Douglas. The segregation of the account per ton is as follows:

First cost	Freight	Crushing and placing	Total
$2.757	$1.749	$3.134	$7.64

Account 8304.3—Hoppers and Chutes.

This account covers the cost of material and the installation of feed hoppers and chutes with their gates and levers to the reverberatories.

Cast-iron hoppers, chutes, weights, levers, bars	$1,216.20
300 ft. $\frac{1}{4}$-in. steel sash cord, 100 clips, 50 thimbles	23.00
102 lb. $\frac{1}{2}$ by 3 flat iron	2.45
200 lb. $1\frac{5}{16}$-in. shafting	12.09
Miscellaneous	9.85
	$1,263.59

(See Figs. 81 and 82.)

Account 8305 Cross and Header Flues Brickwork.

This covers the cost of the tile, brick, mortar, lumber for scaffolds, mason and carpenter labor incident to building the cross and header flues from the reverberatories to the boilers. They are 11 ft. from the ground and 8 ft. by 8 ft. 6 in. in section. The roof is a brick arch held by buck stays. There were red brick, fire brick and 4-in. bottom tile used in the construction. (See Figs. 80, 83, 84 and 85.)

Account 8305.1 Cross and Header Flues Unloading Brick.

This covers the unloading, checking quantities and preparing site for the brick used in the flues.

Account 8305.02 Cross and Header Flues Centering.

This covers the cost of material and labor for making, installing and wrecking the arch center for the flues of 8305.01. Centers were made for about one-half the length and then moved to the other half.

Account 8305.2 Cross and Header Flues Painting Brick.

This covers the cost of painting the outside of the flues with one coat of mineral red and linseed oil when the flues were in service. The steel work of the buck stays was given at the same time one coat of graphite paint.

Account 8306 Flues, Boilers to Reverb. Flue Excavation.

This work covers small pier excavation in red clay. It was picked, shoveled into barrows and transported about 15 ft.

Account 8306.1 Flues, Boilers to Reverb. Flue Foundation.

This foundation is some small piers of plain concrete mixed by machine, 1 part cement to 6 parts sand and gravel, transported by wheelbarrows 125 ft. About 40 per cent. of the vertical surfaces was formed. Every pier has $2\frac{3}{4}$-in. anchor bolts.

Account 8306.2 Flues, Boilers to Reverb. Flue Steel Structure.

See account 7308.2.

This covers seven 6-ft. diameter flues of $\frac{1}{4}$-in. steel with their supports. There were 34.78 tons.

Account 8307 Boiler Building Excavation.

This account covers the digging of two long deep cuts for retaining walls. Two feet of clay were encountered, followed by sand and gravel and boulders with caliche. The ground was partly blasted, all picked, shoveled into wagons and hauled a distance of 600 ft.

Account 8307.01 Waste Heat Boilers Excavation.

This work was digging shallow trenches for small foundations, through red clay and small boulders. The ground was picked, shoveled and hauled 600 ft.

Account 8307.02—Oil-fired Boilers—Excavation.
Same as 8307.01.

Account 8307.05—Boiler Feed Pumps—Excavation.
This was a deep square cut involving 659 cu. yd. through red clay and boulders, into sand, gravel and boulders tightened with caliche. It was partly loosened with powder, picked, shoveled and hauled by wagons 400 ft. The lower half was handled twice, once onto scaffolds and the second time out of the pit.

Account 8307.04—Backfill, Back of Boiler Wall.
This was filling behind a long retaining wall. This dirt was adobe, wetted and tamped in 5-in. layers. The dirt was wheeled 60 ft. to place.

Account 8307.1—Boiler Building—Foundations.
This work covered a reinforced wall 240 ft. long, 11 ft. high, 1 ft. at top, 2 ft. at bottom, with pilasters connected at top with horizontal reinforced concrete beams forming the support for waste heat and oil-fired boilers. Three-fourth inch and $\frac{7}{8}$-in. rods spaced about 6 in. to 8 in. were used together with many foundation bolts. The mixture was 5 sand and gravel to 1 cement, made in a machine and hauled 175 ft. in wagons, thence by wheelbarrow 10 to 15 ft. into place. One hundred per cent. of the vertical surfaces was formed.

Account 8307.11—Waste Heat Boilers—Foundations.
This work covered the reinforced concrete beams noted in 8307.1 required for the waste heat boilers. The other conditions were the same, save 50 per cent. only of the vertical surfaces was formed.

Account 8307.12—Oil-fired Boilers—Foundations.
See account 8307.11.

Account 8307.13—Feed Pumps—Foundation.
This account covered the reinforced cantilever walls for a pit 26 ft. by 26 ft. in plan, 14 ft. high and 1 ft. thick. The rods were $\frac{1}{2}$ in. and $\frac{3}{4}$ in. The mixture was machine mixed 5 sand and gravel to 1 cement, hauled 175 ft. in wagons to place. Seventy-five per cent. of the vertical surfaces was formed.

Account 8307.2—Floor over Slag Track Cut—Floor.
This covered the laying of a 6-in. reinforced concrete floor 30 ft. by 240 ft. over steel I-beams with a mortar finish troweled smooth. The mix was machine made 5 sand and gravel to 1 cement, with 2 to 1 top finish. A $\frac{3}{16}$-in. woven wire triangular mesh was used and 50 per cent. of the surface was formed. The concrete was wheeled in barrows an average of 175 ft. (See Fig. 86.)

Account 8307.3—Floor around Boilers.

This is a 4,000-sq. ft. plain concrete floor of 4 in. laid in blocks with sand joints and given a 2 to 1 top finish. The concrete was machine mixed, 7 sand and gravel to 1 cement and wheeled in barrows about 175 ft. on the average.

Account 8308—Boiler Building—Steel Structure.

See account 7308.2.

There is in this building 35.03 tons of corrugated iron and 257 tons of structural steel.

Account 8308.5—Platforms and Brackets.

These were structural steel walkways installed after the boilers had been piped and bricked, furnished by the Kansas City Structural Steel Co. and erected by the Arizona Copper Co. construction force. There were 29.5 tons of material. The installation necessitated boring for connections and much removing steam piping.

Account 8309—Waste Heat Boilers, Including all steel.

This account covers the cost of the 7 waste heat boilers with the steel framework of the settings erected. These boilers are class M No. 26 Stirling waste heat boilers, for 180 lb. pressure. They have 7,460 sq. ft. of total heating surface and occupy each a space of 16 ft. by 20 ft. 4 in. by 26 ft. $4\frac{3}{4}$ in. The waste heat from the flue, common to all the reverberatories, enters the front of the boilers at the top. (See Fig. 87.)

Account 8309.01—Waste Heat Boilers—Brickwork.

This account covers all red and fire brick and tile with mortar and lumber for scaffolds, as well as mason and carpenter labor entering into the bricking of the waste heat boilers. The unloading of the brick and handling from the pile to the boiler site are taken care of elsewhere. (See Fig. 87.)

Account 8309.02—Waste Heat Boilers—Unloading Brick.

This covers the cost of preparing the site, unloading and checking all brick used under this account.

Account 8309.03—Waste Heat Boilers—Painting.

When the boiler settings were warm, they were given one coat of mineral red in oil. This account covers the labor and material incident to this operation.

Account 8309.05—Waste Heat Boilers—Rehandling Brick.

This covers the cost of handling brick a distance of 250 ft. from piles to site of waste heat boilers in wheelbarrows.

Account 8309.10—Oil-fired Boilers, Including all Steel.

Same as account 8309. (See Fig. 88.)

Boilers were 3, Class M, No. 14 Stirling for oil firing, having each 4.017 sq. ft. of heating surface. Each boiler occupied a space of 10 ft. by 20 ft. 4 in. by 26 ft. $4\frac{3}{4}$ in. The oil burners are not here included, but 3 stacks are of 48-in. diameter each and 60 ft. high above damper frame, made of No. 10 and No. 8 steel. (See Fig. 88.)

Account 8309.11—Oil-fired Boilers—Brickwork.

Same as account 8309.01. (See Fig. 88.)

Account 8309.12—Oil-fired Boilers—Unloading Brick.

Same as 8309.02.

Account 8309.13—Oil-fired Boilers—Painting.

Same as 8309.03.

Account 8309.15—Oil-fired Boilers—Rehandling Brick.

Same as 8309.05, save distance was about 300 ft.

Account 8310—Superheaters—Waste Heat Boilers.

This account covers the cost of the material and the labor of installing 7 Foster superheaters for class M, No. 26 waste heat Stirling boilers.

7 Foster superheaters	$8,256.40
Miscellaneous	32.31
	$8,288.71

(See Fig. 88.)

Account 8310.10—Superheaters—Oil-fired Boilers.

This account covers the cost of the material and the labor of installing 3 Foster superheaters for class M, No. 14 oil-fired boilers.

3 Foster superheaters	$2,675.03
Miscellaneous	81.38
	$2,756.41

Account 8312—Miscellaneous Piping. Boilers and Reverb. Building.

This account covers the cost of material and installation of miscellaneous piping in the boiler and reverberatory buildings. The sizes are various. It is not valuable for unit costs.

Account 8312.1—Excavation.

This account covers excavation and backfill for a long deep trench. The material met with was red clay filled with boulders and sand and gravel. It was done with picks and shovels, and handled 300 ft. with wheelbarrows and slips. Two hundred feet of the trench were cribbed and lagged 20 ft. high. Much of the dirt had to be handled three times in removing it from the trench.

Account 8312.11—Feed Piping from Heating Plant to Feed Pumps.

This account covers the cost of the pipe, pipe conduit, insulating material and the labor incident to installing them in a trench running from the hot water heating plant to the boiler feed pump house back of the boilers. The conduit was ordinary vitrified 15-in. sewer pipe split in halves. The first half was laid in the trench, the joints cemented, followed by the laying of the 8-in. standard wrought iron pipe. About this the asbestos filler was packed and after each section of the conduit top was laid, the filler was stuffed in over the top of the 8-in. pipe to thoroughly cover it. The material account is segregated as follows:

557 ft. 15-in. J. M. sectional conduit	$2,273.47
577 ft. 8-in. wrought-iron pipe	374.49
Asbestos filler and miscellaneous	109.83
	$2,757.79

Account 8312.20—Feed Piping from Pumps to Boilers.

This cost is not valuable for unit purposes. It represents pipe fittings, pipe covering, paint, and the labor of erecting pipe and fittings, covering some of the pipe with insulation, and painting all pipe. The piping was about one steam and two electrical feed pumps at the boilers. It also covers a hot water line the length of the boiler building, a cold water line the same length with connections from each line to each boiler. The two main lines are 6 in. The connections to the boilers are 3 in. The hot water lines are covered throughout. The pipes are of standard strength and the fittings are extra heavy. The labor costs include also the manufacture of all pipe hangers. A further segregation of the material is as follows:

Pipe	$416.39
Fittings	2,408.89
Pipe covering	137.26
Hangers and miscellaneous	78.46
	$3,041.00

Account 8312.5—Blow-off Piping and Drum.

This cost is not valuable for unit purposes. It represents the cost of the material below and the labor of installing it. The blow-off piping runs about 10 ft. beyond the end of the boiler building and discharges there into a steel drum 4 ft. diameter by 4 ft. high, with an 8-in. diameter pipe riser. From the base of the drum it discharges into a sewer pipe nearby. The drum foundation is included in the concrete cost. A segregated material cost is as follows:

225 ft. 2½-in. standard wrought-iron pipe 25 ft. 8-in. standard wrought-iron pipe 20 ft. 2½-in. extra heavy non-rising stem gate valves	$447.93
20 ft. 2½-in. asbestos packed cocks 1 blow-off drum, 4 ft. diam. by 4 ft. high	79.84
	$527.77

Account 8313—Wiring Electrical Feed Pumps.

This covers the wiring of the two 40-h.p. motors of the feed pumps to the mains. The material was as follows:

2 circuit breakers	$31.70
Conduit and covering	85.20
Wiring and miscellaneous	60.99
	$177.89

Account 8313.1—Lighting for Reverb. and Boiler Building.

This represents the material and labor of hanging 104 drop lights in the boiler and reverberatory building.

8 tungsten lamps, 40 watt 96 carbon lamps, 16 c.p. 145 ft. brewery cord 2,710 ft. 1-in. conduit Wire, switches, etc.	$473.19

Account 8314—Slag Launders.

All the material cost and labor installation of these reverberatory slag launders and two converter slag launders are here included. The reverberatory slag launders at the slag end of the furnace consist of a settler and spout. The settler is about 6 ft. by 3 ft. by 2 ft., made of ⅜-in. steel plate and 3-in. by 3-in. angles. The spout leading from the settler to the slag cars is of cast iron 6 ft. 6 in. long and 1 in. thick. The converter slag launders are built of cast iron about 1½-in. thick on the average, in 4-ft. 6-in. sections and are 24 ft. 6 in. long. They are set up aloft in the converter building on a structural steel frame made of 10-in. 15-lb. I's 2½ by 2½ by $\frac{5}{16}$ angles attached to the framework of the building, and lead into the top of the reverberatory furnaces.

Account 8315—Matte Launders.

These launders lead from small settler boxes at the tap holes of the reverberatories along the dirt floors in which they are set to a height of 10 to 12 ft. above the converter building floor where they discharge into properly located matte pots. The small boxes are of ⅜-in. plate with 3 by 3 and 2½-in. by 2½-in. angles. The launders are of cast iron average 2⅜-in. in thickness. Here is included the cost of the above material together with the labor of installing them.

Account 8316—Six No. 14 Wilgus Oil Systems.

This account covers the cost of 6 Wilgus oil pumps, asbestos covering for portions of these pumps, the labor of installing the pumps, the labor of thoroughly overhauling them, required because of the unsatisfactory condition existing in the leaking steam heating coils and the labor of applying the asbestos covering. The $5\frac{1}{4}$-in. by $3\frac{1}{2}$-in. by 5-in. duplex oil pumps were set directly on the concrete floor in front of the oil-fired boilers.

Account 8317—Two Electrical Feed Pumps.

These pumps located back of the boilers were lowered into the 13-ft. pit onto their foundations and set ready for piping connections. They are two vertical triplex, 8-in. by 10-in. Aldrich, electrical driven pumps each attached with flexible couplings to a 40-h.p. motor. The cost covers the material segregated below and the labor of installing the same:

	Factory	Freight	Clifton
Two 40-h.p. motors	$1,700.00	$24.44	$1,724.44
Two vertical triplex pumps	2,794.00	547.07	3,859.07
Spare parts for pumps	518.00		
Miscellaneous			50.46
			$5,633.97

Account 8317.1—One Steam Feed Pump.

Here is given the labor of installing and the material cost of one 10-in. by 6-in. by 12-in. duplex boiler steam feed pump. This pump is located next to the two electrically driven Aldrich pumps of 8317.

Account 8317.2—Crawls and Chain Blocks in Feed Pump House.

This gives the cost of delivering and hanging in place in the feed water pump house two 2-ton steel plate crawls for lower flange of 8-in. I-beam, one 2-ton duplex chain block for 16-ft. lift together with the material cost as segregated below.

Two 2-ton crawls	$53.74
One 2-ton chain block	58.31
	$112.05

Account 8318—Fettling System.

Here is given the cost of installing fettling tracks and cars over the three reverberatories. A structural steel frame to support an 18-in. gauge car and walkway was erected along each side of each reverberatory, being attached to the steel frame of the building. The cost of this material as given below and the labor of installing the same are here covered:

Three 18-in. gauge bottom dump cars with Hyatt roller bearings	$196.83
3 steel turn plates ¼ in. by 72 in. by 138 in.	93.24
18.25 tons fabricated structural steel and rail	1,492.66
2 by 12 lumber for walkways	18.48
Power for riveting and miscellaneous	141.87
	$1,943.08

Converter Plant

Account 8401—Excavation.

This was a large slice, similar to side hill work, through red clay and boulders into sand and gravel tightened with caliche. It was shaken up with powder, plowed, fresnoed through a trap into narrow-gauge side dump cars and conveyed 1,000 to 2,000 ft. by a narrow-gauge locomotive.

Account 8402—Foundation.

This was a big wall same as under 8301, with about 30 piers 5 ft. by 6 ft. by 8 ft. deep. The concrete was machine mixed, 7 parts sand and gravel to 1 cement, transported 75 ft. in concrete buggies and wheelbarrows. About 50 per cent. of the vertical surfaces was formed. Each pier had four 2-in. anchor bolts 6 ft. long.

Account 8403—Converter Building—Steel Structure.

(See account 7308.2). There is in this building 94.01 tons of corrugated iron and 689.85 tons of structural steel.

Account 8404—Converter Stands—Excavation.

This excavation was small rectangular cuts in sand and gravel, made with picks and shovels and handled in wagons 900 ft.

Account 8404.1—Converter Stands—Foundation.

This concrete was the same mix as 8402, but 100 per cent. of its vertical surfaces was formed. It was hauled 300 ft. to place in dump wagon and cars.

Account 8405—Converter Stands and Shells.

This account covers the cost of the material noted below, together with the labor required to install the stands, put together the parts of the converters, erect motors, controllers, solenoid brakes and attach blast connections. The unloading of this material from the cars is in account 8411. The shells were 12 ft. in diameter, of the Great Falls type, having each 28 tuyères of 1½ in. diameter, extra heavy pipe.

Three cast-iron converter stands, with 50-h.p. motors, brakes, controller, etc	$9,801.01
Four 12-ft. converter shells	12,115.46
Blast connections, valves, etc	321.81
	$22,238.28

(See Figs. 126 and 127.)

Account 8405.01—Repairs to No. 2 Stand.

When No. 2 converter shell was let into place by the crane, it was allowed to fall a short distance and cracked the cast-iron stand. The stand was then taken off its foundation and patched with a steel plate.

Account 8405.10—Converter Shells—Brick Lining.

This account covers both the labor and material incident to lining four converter shells and tops with magnesite brick. In bottom of each shell there is an average of 9 in. of silicate of soda and burnt magnesite beneath the brick. Around the sides there are $4\frac{1}{2}$ in. of this material laid in behind the brick. The top is laid with brick only. The material required for one converter is as follows:

28 sacks (286 lb. each) of magnesite cement.
50 sacks (234 lb. each) of burnt magnesite.
5 bbl. (635 lb. each) of silicate of soda.
4,385 magnesite brick of various shapes.

Account 8405.11—Converter Shells—Unloading Brick.

This covers the cost of the shed together with the checking, unloading and piling all magnesite brick, cement, magnesia and sodium silicate.

Account 8406—Cranes.

This covers the cost of two 40-ton Morgan cranes and the labor of installing them on the craneway, and putting together the equipment ready for operation. It does not include the wiring. They were hoisted place on the craneway by the use of two erecting engines. These cranes are of 40-ton capacity, have four motors, span 55 ft. from rail to rail, and are rigged for a 50-ft. lift. Each crane has a 15-ton auxiliary hoist. (See Fig. 90.)

Account 8406.1—Wiring Cranes.

This cost is not valuable as it represents 30 per cent. more labor than should have been spent. The cranes were wired twice because the first time was done improperly. The wiring is largely in conduits. Here too is the cost for the trolley lines from which the cranes take their power.

Account 8407—Clinkering Machines.

These two machines are set 24 ft. above the floor of the converter building on structural steel supports. The steel supports are a part of the converter building and have been costed in that account. The main body of the machine, the mixer, is the frustrum of a cone 13 ft. 6 in. long, whose head end is 5 ft. diameter and whose discharge end is 9 ft. 6 in. diameter. It is made of $\frac{3}{4}$-in. steel plate, lined with 1-in. cast-iron liners. The whole is mounted on trunnions operated by a 50-h.p. motor. The ladle which feeds the converter slag into the head

end is 60 cu. ft. capacity and is tilted by a screw operated by a 15-h.p. motor.

The feeder which lets siliceous ore into the head end to agglomerate with the slag extends from the silica bins to a pipe discharging into the dropping stream of slag. It is a screw conveyor 4 ft. 9¼ in. long. Each machine has a hood connected to a steel flue 2 ft. 6 in. diameter by 36 ft. 8 in. long, leading into the converter dust chamber.

The machinery for two machines enumerated above cost	$11,872.82
Two 50-h.p. motors as above	828.61
Two 15-h.p. motors as above	820.16
2 brakes for ladle tipping motor	176.51
2 traveling switches for brakes	136.44
2 circuit breakers	102.80
Miscellaneous	44.60
	$13,981.94

This cost includes the price of the machines and the cost of installing them.

Account 8407.01 Clinkering Machines—Alteration No. 1.

The teeth on the drive gears had to be chipped off and trued up so as to mesh properly.

Account 8407.02—Clinkering Machines—Alteration No. 2.

Account 8407.03—Clinkering Machines—Electrical Alterations.

Account 8407.1—Wiring Clinkering Machines.

This covers the labor and material of wiring the two 50-h.p. motors and two 15-h.p. motors operating the clinkering machines.

Account 8409—Wiring for Converter Control.

Account 8409.1—Lighting.

This covers the labor of installing the material incident to lighting the converter building, as well as the material itself. There were used thirty-four 16-c.p. carbon lamps, twenty-six 250-watt tungstens, 440 ft. of No. 8 and No. 12 weatherproof wire exposed, 880 ft. of No. 12 wire in ¾-in. conduit, 684 ft. of No. 12 wire in 1-in. conduit.

Account 8410—Air Pipe from Power House—Excavation.

This covers the cost of digging a trench through sand, gravel and big boulders for a 24-in. pipe, with pick and shovel and backfilling the same.

Account 8410.1—Air Pipe from Power House—Laying.

This covers the cost of the material segregated below and the labor of installing it. The pipe was placed underground and ran from the power house to connect with all of the converters. It was built to carry air

under 12 lb. pressure of No. 8 U. S. gauge plate riveted, tested for 25 lb. pressure and painted with asphaltum paint. It was made in 30-ft. sections and fastened together with forged steel flanges.

400 ft. 24-in. pipe, 10 in. cast-iron nozzles, tees and ells	$1,332.70
22 ft. 10-in. pipe and two 10-in. flanges	27.54
Two 24-in. cast-iron gate valves	415.25
Three 10-in. cast-iron gate valves	138.55
Miscellaneous	127.85
	$2,041.89

(See Fig. 89.)

Account 8411—Ladles, Boats, Bails, Tools, Etc.

This account covers the cost of the material segregated below, the labor of unloading it, the labor of unloading material in account 8405, and the cost of material and manufacture of several converter collar pullers, as well as alterations upon the slag ladles and scrap boats.

	Factory	Freight	Total
One 7-ft. by 7-ft. slag boat complete with chain	$362.00	$38.00	$400.00
2 converter scrap boats 9 ft. by 2 ft. 3 ½ in. high by 2 ft. 5 in. wide	512.60	28.02	540.62
3 cast-steel slag ladles	745.90	283.04	1,028.94
2 cast-steel matte ladles (20 tons capacity)	1,152.45	519.11	2,371.56
1 bail	400.00		
1 bail	200.00		
1 pattern	100.00		
4 chains and converter lifting devices			340.63
1 cast-iron skull breaker			124.99
Miscellaneous material for collar, etc			125.65
			$4,932.39

Account 8413—Casting Machines—Excavation.

This covers 2 deep rectangular cuts in sand, gravel and big boulders with pick and shovels. It was loaded into carts and hauled 600 ft.

Account 8414—Casting Machine—Foundation.

The foundation for each machine consisted of a rectangular sump with plain concrete floor enclosed by reinforced concrete retaining walls. The walls were about 6 in. thick, 8 ft. high, reinforced with $\frac{5}{8}$-in. and $\frac{3}{4}$-in. rods. The concrete was machine mixed, 5 parts sand and gravel to 1 cement, hauled in cars 150 ft. dumped and handled to site in wheelbarrows 150 ft. 100 per cent. of the vertical concrete surfaces was formed.

Account 8415—Casting Machine—Cost and Erection.

This account covers the cost of all the material composing 2 casting

machines, and all the labor required to erect on their foundations ready to operate. Each machine has a steel cradle to receive a ladle of molten copper. This cradle is controlled from a pulpit and is tipped by the power from a 20-h.p. motor. It is set high enough to pour into a casting spoon of $1\frac{1}{2}$-in. cast iron whose approximate dimensions are 2 ft. wide by 3 ft. $6\frac{1}{2}$-in. long, and from 7 in. to 1 ft. $5\frac{1}{2}$-in. deep. This casting spoon pours into the moulds which are attached to a heavy steel conveyor. The moulds are 39 in number, made of $2\frac{1}{2}$-in. cast iron reinforced with $\frac{5}{16}$-in. perforated plate. Their inside dimensions are 2 ft. 4 in. by 1 ft. $6\frac{1}{4}$-in. by $3\frac{1}{4}$-in. deep. From the pulpit, by use of power from a 20-h.p. motor, the conveyor with the moulds moves along under a spray of water from needle holes in pipes placed above them until they reach the end of the conveyor where a device in the bottom of the moulds loosens the ingots, allowing them to drop into a tank of water. This bosh is made of $\frac{5}{16}$-in. plate, 3 by 3 and 4 by 3 angles. It is 7 ft. wide, 23 ft. $5\frac{3}{4}$-in. long, and varies in depth from 7 ft. 10 in. to 2 ft. 10 in. The copper bars are removed from here by a steel drag conveyor operated by a 11-h.p. motor, controlled from the pulpit. When the bars leave the bosh and fall onto the striking plate they are handled by a radial crane whose moving end travels on a 40-ft. curved I-beam. Along the radial crane beam travels a small air hoist capable of picking up 1 ton. It operates under an air pressure of 16 lb. A jib crane is so located, attached to a building column, that it can handle the moulds for removing and replacing. It has a 3,000 lb. capacity triplex block and 8-in. I-beam trolley. Below is a segregated material list:

2 casting machines	$18,657.89
Two 11-h.p. and four 20-h.p. motors	2,933.88
2 jib cranes	327.22
2 radial cranes	1,167.91
2 traveling switches	135.75
2 brakes for ladle tipping motors	176.51
4 circuit breakers	103.50
Moulds, etc	708.55
	$24,211.21

(See Figs. 128 and 129.)

Account 8415.1—Casting Machine—Repairs.

Account 8416—Loading Platform—Excavation.

Same as 8413, except that it was not hauled away.

Account 8416.1—Loading Platform—Foundation.

This was a low retaining wall of gravity section 300 ft. long, machine mixed, 7 sand and gravel to 1 cement, transported in cars 150 ft. by wagon 350 ft. and by wheelbarrow 70 ft. One hundred per cent. of its vertical surface was formed.

Account 8416.11—Loading Platform—Floor.

This was a plain concrete floor mixed and handled as above, with a ½-in. finish of 2 sand to 1 cement. There were no joints in the concrete. The finish was troweled smooth.

Account 8416.2—Loading Platform—Backfill.

Behind the 300-ft. wall—8416.1 sand and gravel was backfilled. The material lay 8 to 10 ft. from the wall.

Account 8416.3 Loading Platform—Striking Plates.

Two striking plates, one at each casting machine are placed so that the copper ingots discharged from the casting machine elevator fall directly upon them. They were made by setting 4 by 4 by 4½-in. wood blocks dipped in hot tar and placed on end upon a concrete base. Over the blocks a steel plate 6 ft. ½ in. by 9 ft. 10 in. by ½ in. was laid and secured by 16 ¾ by 2½-in. bolts, grasped by cast-iron fasteners set in concrete below.

283 ft. b.m. lumber	$8.59
2 steel plates	99.19
32 cast-iron fasteners and bolts	18.91
	$126.69

Account 8417—Hoods and Smoke Boxes.

This account covers all the material of the converter hoods, smoke boxes, flues leading to converter dust chamber, together with the labor of erecting them. It likewise includes removing the stacks 4 ft. in diameter, making new ones 5 ft. in diameter and erecting them together with change required to put large doors in the back of the boxes. The smoke boxes, of which there are three, are made of ⅜-in. plate, and 4 by 4 by ¾ angles. They are 16 ft. high and about 9 ft. in diameter. The hoods, of which there are three, are made from ½-in. plate and 4 by 4 by ⅜ angles. They hang on the front of the smoke boxes and direct the gases into the flues. The original stacks, of which there were three connecting the smoke boxes and the converter dust chamber, were 4 ft. diameter and 26 ft. long, made of $\frac{3}{16}$-in. plate. They were replaced by similar ones 5 ft. in diameter. (See Fig. 92.)

Account 8417.1—Hood to Protect Converter Operator.

Only one of these was made. Three-sixteenth inch plate was used. The dimensions are 7 ft. 2 in. by 7 ft. 2 in. by 7 ft. 8 in. high, one end is open. The account covers material used, fabrication and erection.

Account 8418—Spouts, Gates and Hoppers at Silica Ore Bins.

This account covers the material cost of the gates with operating devices, the 10-in. pipe chutes and the labor of erecting same, together

with the labor of erecting the hoppers. The hoppers were furnished by the Kansas City Structural Steel Co., and are costed with the building. The hoppers are situated below the silica bins, above the converters and by a spring device and pointer indicate to an operator on the ground when they have been filled to the desired amount. The gates allow the material to flow through a 10 in. pipe chute directly into each converter. These chutes can be turned aside from the converter mouth by a chain, wheel and gear so as not to interfere when out of use. (See Fig. 93.)

Account 8419.1—10-ton Bullion Scales—Excavation.

The excavation consisted of small cuts made in sand and gravel with pick and shovel and cast to one side.

Account 8419.2—10-ton Bullion Scales—Foundations.

This concrete was cast plain in low 8-in. thick walls about a pit 4 ft. by 6 ft. in plan. The mix was machine made, 6 sand and gravel to 1 cement, and transported a distance of 1,900 ft. in wagons. Seventy-five per cent. of the walls' vertical surface was formed.

Account 8419.3—10-ton Bullion Scales—Cost and Erection.

This represents the cost of the scales and the labor of installing them. The scales were pit pattern, 10-ton copper bullion class, with type registering beam weighing to 1 lb. They came complete with all necessary structural steel framework and cast-iron platform plate.

Account 8419.4—10-ton Bullion Scales—Scale House.

This is a shed roof building without sides about 16 ft. by 20 ft. The roof is of 1-in. sheathing, covered with composition roofing. It was painted 2 coats of oil and lead.

Account 8425—Conveyor No. 15.

(See account 7405.)

Conveyor No. 15 is a 20-in. belt, making a conveyor 165 ft. long, running perfectly flat, operating at a speed of 300 ft. per minute, capable of handling 100 tons per hour. It receives material from conveyor 14 and delivers it to the silica bins of the conveyor building through an automatic tripper. The account is segregated as follows:

Belt	$664.19
Robins Material	1,231.91
Centrifugal switch	36.20
Lumber (decking, etc.)	67.05
Spout from No. 14 to No. 15	31.21
29 ft. 6 in. of 5-in. d.l. drive belt	20.82
7½-h.p. motor	138.75
Miscellaneous	61.34
	$2,251.47

(See Fig. 91.)

Account 8426.1—Wet Pan—Excavation.

Account 8426.2—Wet Pan—Foundation.

This concrete was hand mixed. Owing to some conditions not satisfactorily ascertained the concrete did not set. This necessitated its being put in twice. The yardage is that of one installation and the cost two. The mix is 7 to 1.

Account 8426.3—Wet Pan—Cost and Erection.

This mill was installed to furnish "mud" for the converters and reverberatories. The account covers the material segregated below and the labor of installing the same.

One 5-ft. wet pan; size of mullers 36 in. by 4½-in.; pulley 34 in. by 10-in.; 4-arm type friction clutch	$634.34
One 15-h.p. motor, 860 r.p.m. squirrel-cage with starting compensator	248.45
One 18 by 10 solid hub cast-iron pulley	15.47
One 38 by 7 solid hub cast-iron pulley	24.71
Two 2 $\frac{1}{16}$ by 24-in. drop hangers	23.48
11 ft. by 2 in. 2 $\frac{1}{16}$ shafting, collars, etc	13.10
30 ft. 6-in. double leather belting	25.39
35 ft. 9-in. double leather belting	44.42
Miscellaneous	20.74
	$1,050.10

Account 8426.4—Wet Pan—Bins and Spout.

This bin with spout was made in the smelter shops, using ¼-in. steel plate. It has a capacityof 260 cu. ft. The account covers the material used, labor of fabrication and erection.

Converter Dust Chamber

Account 8421—Excavation.

This account covers the making with pick and shovel of small cut for a retaining wall, and digging a number of small pier holes. The material was red clay and stones, running into sand and gravel which was loaded into carts and hauled 600 ft.

Account 8422—Foundation.

This concrete was cast as piers about 4 ft. by 4 ft. by 5 ft. about 45 per cent. of whose vertical surface was formed. It was mixed in a machine, in the proportions of 7 sand and gravel to 1 cement, transported by cars and wheelbarrows 200 ft. The pier tops were finished to a perfect elevation to receive structural steel columns.

Account 8423—Steel Structure.

(See account 7308.2.) This structure contained 228.18 tons of structural steel and 10.12 tons of Keystone plate roofing. (See Fig. 94.)

Account 8423.01—Wire Baffles.

(See account 8132.01, for description.) This account covers the cost of the material below and the labor incident to its erection.

14,365 lb. No. 10 steel wire baffles	$670.34
8,500 lb. ⅜-in. steel chains, 2-in. links	430.91
Miscellaneous	0.70
	$1,101.95

(See Figs. 94 and 95)

Account 8423.1—Tile Work.

This is identical with 8123.1.

Account 8423.11—Unloading Tile.

This is identical with 8123.11.

Account 8424—Iron Doors and Frames.

This covers the cost of the cast-iron doors, etc., set in the tile work of the converter dust chamber. The labor represents hauling the same to the site. The labor of setting is included with the tile work.

5 cast-iron peep doors and frames, doors 4 ft. 6 in. by 2 ft. 6 in..... $158.93

Account 8428—Smoke Box Track.

This is a track back of the smoke boxes for the converters. The material is second hand, picked up from construction equipment. The account is of no value.

Conveying System

Account 8501—Excavation.

This covers excavation made at various times for piers and trenches for walls to support the conveying system structures. The ground was mostly red clay and boulders, sometimes sand and gravel. The excavating was done with pick and shovel and the material cast to the side of the cuts.

Account 8502—Foundation.

This account covers plain concrete cast in a great many piers, and reinforced concrete cast in a shape to make two long tunnels through which conveyors 11 and 14 rise from below conveyors 10^1 and 10^2 located under the bunker bins. The tunnels are 6 ft. by 6 ft. with 12-in. walls, reinforced with ½-in. and ¾-in. rods, spaced 6 in. About 80 per cent. of the vertical surfaces was formed. All concrete was machine mixed in different proportions and transported variously to the many different situations.

Account 8503—Steel Structure.

(See account 7308.2.) There were here used 30.94 tons of corrugated iron, and 180.79 tons of structural steel. These structures are elevated steel conveyor ways.

Account 8504—Woodwork.

This account represents the labor and material of flooring the steel conveyor ways for conveyors 3, 4, 5, 6, 11 and 14. The lumber used was 2 by 12 S1S2E No. 1 merchantable Oregon pine. On No. 14 the 2 by 12's were rabbeted. Considerable cutting was done to frame about conveyor steel frame supports. This cost includes also attaching nailing strips to the steel work to which the flooring was nailed. (See Fig. 96.)

Account 8504.1—Floor Battens.

This account covers labor and material incident to nailing battens beneath the floor boards of conveyors 3, 4, 5, 6 and 11. The lumber here used was not rabbeted.

Account 8505—Conveyors No. 3, 4, 5, 6, 11 and 14.

(See account 7405.) Conveyor No. 3 has a 20-in. belt, making a conveyor 182 ft. 5½ in. long, rising 46 ft., operating at a speed of 250 ft. per minute, with a capacity of 150 tons per hour. It conveys concentrates from No. 2 belt into the sampling mill.

Conveyor No. 4 has a 20-in. belt, making a conveyor 220 ft. 9 in. long, rising 64 ft., operating at a speed of 250 ft. per minute, having a capacity of 100 tons per hour. It takes crushed ore from the crushing plant to the top of the sampling mill.

Conveyor No. 5 has a 20-in. belt, making a conveyor 127 ft. long, having a rise of 26 ft. 4 in., operating at a speed of 250 ft. per minute, with a capacity of 150 tons per hour. It carries the fines from the sample mill on their way to the beds.

Conveyor No. 6 has a 20-in. belt, making a conveyor 113 ft. 8 in. long, having a rise of 25 ft. 6 in., operating at a speed of 250 ft. per minute with a capacity of 100 tons of ore per hour. It carries material from the sample mill on its way to the bunker bins.

Conveyor No. 11 has a 20-in. belt, making a conveyor 369 ft. 8½ in. long, having an 87-ft. rise, operating at a speed of 300 ft. per minute with a capacity of 100 tons per hour. It conveys the product from conveyor 10^1 to conveyor 12 at the Roasters.

Conveyor No. 14 has a 20-in. belt, making a conveyor 271 ft. 5 in. long, having a 71-ft. rise, operating at a speed of 300 ft. per minute with a capacity of 100 tons per hour. It takes ore from conveyor 10^2 beneath the bins to conveyor 15.

The material for these conveyors somewhat segregated is as follows:

	Factory	Freight	Clifton
Belt	$5,351.03	$365.88	$5,716.91
Robins material	4,290.86	530.49	4,821.35
Extra pulley	.....	.....	38.00
4 centrifugal switches	136.00	8.81	144.81
One 10, one 15, and four-20-h.p. motors	.....	.....	1,309.68
5 overload releases	65.00	6.25	71.25
Miscellaneous, decking, etc	.....	.....	403.62
			$12,505.62

Account 8505.1—Chutes.

This cost is of no value.

Account 8505.2—Guides.

The belts in the conveying system could not be made to run true on the troughing idlers. To overcome their riding out of position long boards were fixed at the sides of the belts to guide and keep them in position. These boards were picked up about the plant and the cost represents only the labor of installing them.

Account 8505.3—Weightometer.

This account covers the cost and labor of installing a Merrick weightometer on conveyor 11. The weightometer is installed on a 20-in. inclined conveyor belt with a speed of 300 ft. per minute, whose angle of inclination is 13 degrees 28 minutes and whose troughing idlers are 4 ft. on center lines. The belt has a normal capacity of 100 tons per hour.

Account 8506—Lighting.

This represents installing the following lights:

33 drops
1,285 ft., No. 12 weatherproof wire
120 ft. of conduit

Chimney

Account 8601—Excavation.

This was a deep hexagonal cut made through clay, caliche and well into sand and gravel containing big boulders. The material was loosened with picks, slipped out with fresnos, dumped through a trap into carts and hauled 2,700 ft.

Account 8602—Foundation.

This was a very large block of concrete cast in a hexagonal shape 20 ft. deep and 50 ft. inside least diameter. In the bottom of the block 3 layers of 1-in. rods laid 1 ft. on centers were placed. The mixture was machine made, 8 parts sand and gravel to 1 cement, using lots

of large rock. About 40 per cent. of the vertical surface was formed. The concrete was transported in cars 100 ft.

Account 8603—Brickwork.

The stack was contracted erected by the Alphons Custodis Chimney Construction Co. It is 300 ft. high, 26 ft. 8 in. inside diameter at the base and 22 ft. at the top. The average thickness of the walls is about 24½ in. Every 25 ft. inside the stack is corbelled out to hold the lining of radial perforated fire brick, laid in acid-proof mortar. The base of the stack is of red brick and the round portion is of perforated radial blocks. The outside upper 75 ft. of the stack were pointed with acid-proof mortar. There was used in the construction:

138,000 lb. lime	652 tons wire cut brick
290 lb. cement	56 tons wedge brick
1,638 tons radial brick	100 bbl. acid-proof mortar

The cost here given includes constant inspection by the Arizona Copper Co. organization. (See Fig. 97.)

Reverberatory Flue

Account 8611—Excavation.

This covers the excavating of some long deep trenches for footings and a large amount of back filling. It was done in red clay and gravel with picks and shovels. The back filling was wheeled 25 ft. to place and tamped in 5-in. layers.

Account 8612—Foundation.

This concrete was cast in 2 long reinforced concrete cantilever type retaining walls. The walls were 12 in. at the top, 14 in. at bottom, and 5 ft. high. One-half-inch and ¾-in. rods, spaced 6 in. centers, were used. The mixture was machine mixed in the proportion of 5 sand and gravel to 1 cement, transported in wagons, wheelbarrows and concrete carts 250 ft. to place. Ninety-five per cent. of the vertical surface of the concrete was formed.

Account 8613—Brickwork.

This account is similar to others of the same nature, including cost of tile, mortar, scaffolds, and the labor of masons, their helpers, and carpenters. (See Figs. 98 and 100.)

Account 8613.01—Unloading Brick.

This covers the cost of preparing site, unloading tile, and the checking of same.

Account 8614—Steel Structure.

(See account 7308.2.) There were 32 tons of structural steel used here and 9.61 tons of Keystone plate roofing. (See Fig. 99.)

Account 8614.1—Clean Out Doors.

This covers the cost of labor of altering and material in the clean out doors and frames for this flue

18 cast-iron frames and steel plate doors, $\frac{3}{16}$ in. by 16½ in. by 2 ft. 2½ in	$128.27
½-in. sheet steel and miscellaneous	25.34
	$153.61

Account 8614.2—Caulking Roof.

This account covers the labor and material of making as nearly air-tight as was possible the roof to this flue. Asbestos wicking was caulked into all the bad joints.

Converter Flue

Account 8621—Excavation.

This was a small amount of excavation for a number of piers through red clay with boulders and sand and gravel. It was done with pick and shovel, the dirt being cast to the sides of the holes.

Account 8622—Foundation.

These foundations were 14 plain concrete piers about 4 ft. 6 in. by 4 ft. 6 in. by 5 ft. The concrete was machine mixed, about 7 parts sand and gravel to 1 cement, and transported 200 ft. in wheelbarrows and concrete carts to place. Seventy-five per cent. of the vertical surfaces was formed.

Account 8624—Steel Structure.

(See account 7308.2.) 81.99 tons of structural steel were used here. (See Fig. 101.)

Roaster Dust Chamber Flue

Account 8626—Excavation.

This excavation covers the cuts for a number of piers through red clay containing boulders, made with pick and shovel and thrown to one side of the excavation.

Account 8627—Foundation.

This concrete was cast in 12 piers about 4 ft. 6 in. by 4 ft. 6 in. by 5 ft. It was plain concrete, machine mixed in proportions of 7 sand and gravel to 1 cement, and was transported to place 200 ft. in cement cars and wheelbarrows. Seventy-five per cent. of the vertical surface was formed.

Account 8628—Brickwork.

This is the same as 8123.10. (See Figs. 99, 100, 102, and 104.)

Account 8628.01—Unloading Tile.

This is the same as 8123.11.

Account 8629—Steel Structure.

There were 85.21 tons of structural steel used here and 9.25 tons of Keystone plate roofing. The flue is 6 ft. 6 in. by 12 ft. in cross section and connects the roaster dust chamber with the stacks. (See Fig. 102.)

Boiler and Blacksmith Shop

Account 8701—Excavation.

This excavation involved making a 6-ft. slice to get the proper grade for the building site, together with piers and small wall excavation. It was plowed and slipped away in fresnos 400 ft.

Account 8702—Foundations.

These foundations were the small walls and piers for the brick and steel column supports. The concrete was plain, hand mixed in the proportions of 6 sand and gravel to 1 cement, and handled 100 ft. in wheelbarrows to the forms. Fifty per cent. of the vertical surface was formed. This was the first concrete cast at the smelter.

Account 8703—Steel Structure.

There were 32.72 tons of structural steel used in the framework of the building. (See Fig. 105.)

Account 8703.1—Doors, Windows and Frames.

This account covers the purchase price of all doors, windows, their frames, lintels and glass. It also covers the labor of installing the steel lintels which run from building column to building column; the erection of the steel door and window frames; the erection of the steel sash and doors; and the glazing of these doors and windows. After the lintels had been framed in, the tile work brought up to sill base and the sill set, the frames were put in place, bolted to the lintels and tied by rods back to the building columns. When the frames had been entirely bricked in, the steel sash were bolted in place and later glazed. A segregated material list is as follows:

Thirteen 11 ft. 7 in. by 12 ft. ¾ in. steel sash 63 lights, 2 mullions, with 3 to 6 light ventilators, not glazed.

One 10 ft. 3 in. by 12 ft. ¾ in. steel sash 56 lights, 1 mullion, no ventilators not glazed.

Two 10 ft. 3 in. by 12 ft. ¾ in. steel sash, 48 lights, 1 mullion, no ventilators, not glazed.

One 4 ft. by 9 ft. steel sliding door, with six 14 in. by 20 in. lights, not glazed, lower panels steel plate.

One 8 ft. by 9 ft. steel sliding door, with eighteen 14 in. by 20 in. lights, not glazed, lower panels steel plate.

One 14 ft. by 20 ft. Kinner steel rolling door.

One 10 ft. by 10 ft. Kinner steel rolling door.
Eleven 14-ft. 10-in. lintels built up of 8-in. channels.
Two 13-ft. 4-in. lintels built up of 8-in. channels.
Two 11-ft. 6-in. lintels built up of 8-in. channels.
One 10-ft. 4-in. lintels built up of 8-in channels.
One 11-ft. 6-in. lintels built up of 8-in. channels.
850 lights 14 in. by 20 in., $\frac{1}{8}$ in. factory ribbed glass,
164 lights $13\frac{1}{8}$ in. by $19\frac{1}{8}$ in. factory ribbed glass.
82 lights 14 in. by $19\frac{1}{8}$ in. factory ribbed glass.
44 lights $13\frac{1}{2}$ in. by 20 in. factory ribbed glass.
Steel windows and door frames for above made of two $3\frac{1}{2}$ by $2\frac{1}{2}$ by $\frac{1}{4}$ angles.
(See Fig. 106.)

Account 8703.11—Concrete Sills.

This account covers the labor and material used to make the following list of concrete sills. The sills were made 3 parts sand and gravel to 1 cement, cast in collapsible moulds and later finished. Three $\frac{5}{8}$-in. rods are used in each sill.

11 sills, $8\frac{1}{4}$ in. by 10 in., 14 ft. 10 in. long.
1 sill, $8\frac{1}{4}$ in. by 10 in., 11 ft. 6 in. long.
1 sill, $8\frac{1}{4}$ in. by 10 in., 8 ft. 6 in. long.
2 sills, $8\frac{1}{4}$ in. by 10 in., 12 ft. 2 in. long.

(See Fig. 21.)

Account 8703.2—Tile Walls.

This cost includes the cost of tile, mortar and scaffolds, together with the mason and carpenter labor used to build the walls. The walls were non-bearing 8 in. thick, built of hollow tile, laid in between the steel building columns. The mortar used was 1 cement, 1 lime and 1 sand.

Account 8703.21—Unloading Tile.

This covers the cost of preparing site, unloading, and checking quantity of tile.

Account 8703.22—Coping.

This covers the cost of labor and material incident to coping the walls at the top, beneath the roof. A two by four was bolted to the top course of tile and another to the underside of the roof. These were lathed across with metal lath and plastered with cement mortar. (See Fig. 17.)

Account 8703.30—Roof.

This account covers the cost of the material and labor incident to roofing the boiler and blacksmith shop. Oregon pine sheathing, 2 by 8, surfaced, tongued and grooved, was nailed to strips bolted to the purlins. Over this 3-ply asbestos roofing paper was laid. (See Fig. 17.)

Account 8703.31—Ventilators.

This covers the cost of labor and material incident to installing three 48-in. Burt ventilators on the peak of the boiler and blacksmith shop roof.

The ventilators were skidded up onto the roof with hand tackle along a runway, bolted to the purlins and flashed. (See Fig. 18.)

Account 8703.4—Dirt Floor.

This account covers the labor incident to bringing the dirt floor of this building to the required grade. The dirt was wheeled in and tamped in 3-in. layers.

Account 8703.5—Benches.

This account covers the labor and material of making from time to time benches, racks and the like used in this shop.

Account 8703.6—Painting.

This covers the cost of painting all the steel sash one coat of "turkey red." and the woodwork, namely, the under side of the roof two coats of white lead and linseed oil, cream color.

Account 8704—Crane.

This covers the purchase of the crane listed below, the labor of overhauling and erecting it.

One 3-ton hand power traveling crane, chain block transfer type 18-ft. span, complete with roller bushed geared trolley and provided with 3-ton triplex chain block for 13 ft. lift	$378.35
Miscellaneous	60.06
	$438.41

Account 8705—Tools.

This account covers the purchase price of the tools enumerated below and the labor required to install them.

	Factory	Freight	Clifton
1 No. 2 punch and shear, Hilles & Jones	$1,530.00	$435.00	$1,965.00
1 No. 0 bending rolls	580.00	75.00	655.00
One 1,100-lb. steam hammer, Niles-Bement-Pond Co. 1 blower, size 5, type D, American Blower Co...	1,015.00	408.00	1,423.00
One 5-h.p. 440-volt, 3-phase, 60-cycle 1,720-r.p.m. motor	160.00	19.90	179.90
1 No. 5 swage block	.....	.....	35.08
1 Peter Wright anvil, weight 497 lb	.....	.....	70.57
10 in. galv. iron pipe and connections	.....	.....	106.63
3 sheets steel, ⅛ in. by 48 in. by 120 in	.....	.....	16.02
One 2-in. heading, upsetting and forging machine, Acme Machinery Co	2,790.00	440.70	3,230.70
1 sisco anvil, 407 lb	.....	.....	46.60
1 Hay Budden anvil, 420 lb	.....	.....	48.10
40 ft. of 6-in. I-beam	.....	.....	12.62
Castings	.....	.....	41.00
Miscellaneous	.....	.....	29.14
			$7,859.36

Account 8706—Shafting, Pulleys, Belting.

This account covers the purchase price of the list of material below and the labor of installing the same, and the necessary wooden bridge trees.

33 ft. of $2\frac{7}{16}$-in. and 18 ft. of $2\frac{15}{16}$-in. shafting.
5 pulleys, varying from 26 in. to 52 in. with bearings and hangers.
1 length of 8-in. double leather belt, 104 ft. long.
1 length of 6-in. double leather belt, 140 ft. long.

(See Fig.19.)

Account 8707—Motor.

This account covers the purchase price of the material below and the labor of installing it. This motor furnished the power for the boiler and blacksmith shops.

One 20-h.p. 440-volt, 3-phase, 60-cycle, 850-r.p.m. motor.

Account 8708—Lighting.

This account covers the cost of the material below and the labor of its installation.

14 carbon lamps, 16 c.p.	260 ft. brewery cord
3 tungstens, 250 watt	300 ft. No. 12 wire

100 ft. conduit.

Machine and Carpenter Shop

Account 8715—Excavation.

Same as account 8701.

Account 8716—Foundation.

Same as account 8702.

Account 8717—Steel Structure.

This building is the same as 8703 account. There were used here 38.23 tons of structural steel. (See Fig. 105.)

Account 8717.1—Doors, Windows and Frames.

This account is the same as 8703.10, with the following list of material:

Thirteen 11 ft. 7 in. by 12 ft. $\frac{7}{8}$ in. steel sash, 63 lights, 2 mullions, with 3 to 6 light ventilators, unglazed.
Two 10 ft. 3 in. by 12 ft. $\frac{7}{8}$ in. steel sash, 56 lights, 1 mullion, no ventilators, unglazed.
Two 10 ft. 3 in. by 12 ft. $\frac{7}{8}$ in. steel sash, 48 lights, 1 mullion, no ventilators, unglazed.
Two 4 ft. by 9 ft. steel sliding doors, with six 14 in. by 20 in. lights, unglazed, lower panels steel.
One 11 ft. by 12 ft. steel sliding door, with forty 14 in. by 20 in. lights, unglazed, lower panels steel.
Two 14 ft. by 20 ft. Kinner steel rolling doors.

Fourteen 14-ft. 10-in. lintels, made of 8-in. channels.
Six 11-ft. 6-in. lintels, made of 8-in. channels.
Seven hundred forty 14 in. by 20 in., $\frac{1}{8}$ in. thick factory ribbed glass window panes.
One hundred sixty-four 13$\frac{1}{8}$ in. by 19$\frac{1}{8}$ in., $\frac{1}{8}$ in. thick factory ribbed glass window panes.
Eighty-two 14 in. by 19$\frac{1}{8}$ in., $\frac{1}{8}$ in. thick factory ribbed glass window panes.
Twenty 15 in. by 20 in., $\frac{1}{8}$ in. thick factory ribbed glass window panes.

Steel window and door frames for the above list. (See Fig. 106.)

Account 8717.11—Concrete Sills.

Same as account 8703.11, but the following product:

Thirteen 8$\frac{1}{4}$ in. by 10 in., 14 ft. long sills.
Two 8$\frac{1}{4}$ in. by 10 in., 11 ft. 6 in. long sills.
Two 8$\frac{1}{4}$ in. by 10 in., 6 ft. 6 in. long sills.

(See Fig. 21.)

Account 8717.20—Tile Walls.

Same as account 8703.20.

Account 8717.21—Unloading Tile.

Same as account 8703.21.

Account 8717.22—Wall Coping.

Same as account 8703.22.

Account 8717.30—Roof.

Same as account 8703.30. This roof contains 77.21 squares, equal to 14,543 b.m. 2 by 8 lumber.

Account 8717.31—Ventilators.

Same as account 8703.31. Three 48-in. Burt ventilators used here.

Account 8717.40—Floor.

This account covers the cost of the material and labor required to lay this floor. Six inch by eight inch stringers were laid 2 ft. 6 in. on centers with earth tamped in between them. On the stringers No. 3 grade, 3 in. by 12 in. white cedar planking of various lengths was spiked down. (See Fig. 24.)

Account 8717.50—Benches.

Same as account 8703.50.

Account 8717.60—Painting.

Same as account 8703.60.

Account 8718—Crane.

This is the same as account 8704, with the exception that the crane here used is of 5 ton capacity.

Account 8719—Tools.

This account covers the purchase price of all the material listed below and the labor cost of installing it:

	Factory	Freight	Clifton
1 Prentiss machine bench vise, No. 2..	.....	.....	$20.15
1 machine bench vise, No. 21.....	.....	.....	20.16
1 machine bench vise, No. 22.....	.....	.....	28.85
1 machine pipe vise, No. 2A.....	.....	.....	2.38
1 machine pipe vise, No. 4A.....	.....	.....	7.77
1 stationary bench vise, No. 56.....	.....	.....	20.72
40 ft. of 1½-in. pipe.....	.....	.....	2.97
1 No. 48 power grindstone.....	.....	.....	56.62
2 emery wheels.....	.....	.....	8.90
1 emery wheel grinder.....	.....	.....	17.00
1 No. 40 special turning machine.....	.....	.....	36.22
1 set faces for wiring machine.....	.....	.....	5.56
1 gauge.....	.....	.....	2.35
1 burr machine and stand.....	.....	.....	9.92
1 No. 17 S. P. crimper and stand.....	.....	.....	10.77
1 No. 3 beading machine.....	.....	.....	26.79
1 No. 0236 squaring shears.....	.....	.....	180.86
1 stake-holder and stakes.....	.....	.....	42.15
1 rivet set.....	.....	.....	2.65
1 No. 101 tinner's rule.....	.....	.....	2.73
1 power hack saw No. 3.....	.....	.....	29.63
1 radial drill press, 42 in.....	.....	.....	752.20
Miscellaneous.....	.....	.....	21.92
1 50-in. cornice brake.....	.....	.....	155.96
1 16-in. rip saw.....	.....	.....	4.30
Castings.....	.....	.....	10.10
1 No. 1 drill chuck.....	.....	.....	5.61
1 No. 2½ drill chuck	.....	.....	7.02
72 hack saw blades.....	.....	.....	5.55
1 surfacer, 20 in. by 6 in.....	$180.00	$26.70	206.70
1 No. 50 hand saw.....	175.00	27.45	202.45
1 lathe, 14 in. by 8 ft.....	563.75	81.40	645.15
1 lathe, McCabe patented double spindle.	2,111.00	277.15	2,388.15
1 Crescent saw table.....	168.75	51.34	220.09
One 20-in. Rockford shaper.....	425.00	175.07	600.07
One 2-in. bolt cutter.....	355.00	47.10	402.10
1 Crane pipe machine 2 in.....	192.00	16.56	208.56
1 Crane pipe machine 4 in.....	480.00	44.10	524.10
1 Crane pipe machine 12 in.....	1,500.00	163.59	1,663.59
Small tools, miscellaneous equipment	.....	.....	394.36
			$8,953.13

Account 8720—Shafting, Pulleys and Belting.

This account covers the purchase price of the material below and its cost of installation:

1 pc. 30 ft., 2 15/16 in. diameter shafting.
1 pc. 60 ft., 2 15/16 in. diameter shafting.
1 pc. 18 ft., 2 15/16 in. diameter shafting.
1 pc. 18 ft., 2 7/8 in. diameter shafting.
1 pc. 22 ft., 2 7/8 in. diameter shafting.
1 pc. 10 ft., 2 7/8 in. diameter shafting.
1 pc. 4 ft., 2 7/8 in. diameter shafting.

Many pulleys ranging from 10 in. to 68 in. diameter, with necessary hangers, collars, boxes, etc. (See Fig. 19.)

Account 8721—Motor.

This account covers the purchase price and cost of installing the following motor.

One 40-h.p., 440-volt, 3-phase, 60-cycle, 850-r.p.m. motor.

(See Fig. 20.)

Account 8722—Lighting.

This covers the cost of the following material and the labor of installing it.

17 carbon lamps	16 c.p.
3 tungstens	250 watt
240 ft. brewery cord	
100 ft. conduit	
360 ft. No. 12 weatherproof wire.	

(See Fig. 23.)

General Office

Account 8804—Furniture and Fixtures.

This account covers the furniture and fixtures purchased for the smelter office, which to date has not been built. The furniture is in use in the temporary offices.

Warehouse

Account 8810—Excavation.

This was the same as 8701.

Account 8811—Foundation.

This was the same as 8702, save that the walls were higher.

Account 8812—Steel Structure.

This building is the same type as the boiler and machine shops, save a corrugated iron roof was used in place of a wood and paper covering. There were 26.5 tons of structural steel used and 13.26 tons of corrugated iron. (See Fig. 26.)

Account 8812.1—Doors, Windows and Frames.

The doors for the warehouse were similar to the boiler and machine shops. The lintels over the windows and doors were the same as in

the shops. The small doors, all windows and frames were wood. This account covers the cost of the door and window material listed below and the labor of installing the same.

51 windows, 3 ft. 9⅞ in. by 7 ft. 8¾ in. by 1⅝ in. These were grouped 16 in triple frames, all glazed	$305.99
16 wood frames for 48 of above windows	170.32
Lumber for 3 window frames, all door frames and all hardware	83.78
1 O. G. 1 light glazed door, 3 ft. 6 in. by 7 ft. 1 3/8 in.	7.91
Two 9 ft. 10 in. by 7 ft. 6½ in. Kinner rolling doors	157.30
Steel lintels	331.01
(See Fig. 27.)	
	$1,056.31

Account 8812.11—Concrete Sills.

See account 8703.11. Sills were made here for frames of account 8812.10. (See Fig. 22.)

Account 8812.2—Tile Walls.

Same as for account 8703.11.

Account 8812.21—Unloading Tile.

Same as for account 8703.21. (See Fig. 26.)

Account 8812.22—Coping.

Same as for account 8703.22. (See Fig. 28.)

Account 8812.3—Painting Roof.

This covers the labor and material of painting underside of corrugated iron roof 2 coats of lead and linseed oil, cream color.

Account 8812.31—Ventilators.

Same as for account 8703.31. These three ventilators were 48 in. diameter with round base. (See Fig. 25.)

Account 8812.40—Floor Excavation.

This entailed cutting down the front in the warehouse 6 to 8 in. and backfilling in places.

Account 8812.41—Floor Concrete.

This concrete floor was cast in large 6 ft. to 8 ft. blocks, 4 in. thick, with sand joints between blocks. The concrete was hand mixed in the proportions of 6 sand and gravel to 1 cement. It was transported in wheelbarrows 100 ft. The top finish, ¾ in. thick, was 2 sand to 1 cement. This top was troweled smooth.

Account 8812.50—Lighting.

This account covers the cost of the following material and the labor of installation.

26 carbon lamps, 16 c.p. 365 ft. brewery cord
170 ft. No. 12 weatherproof wire.

Account 8813—Fixtures.

This account covers the purchase price of the steel bins, shelving, counter scales, office partition and furniture, as listed below; also the erection cost.

197 ft. Bergers sectional steel bins and shelving. See sketch, lineal feet refers to half of bins shown by sectional elevation. Bins received knocked down, gauge of material 16 to 20	$1,116.82
1 No. 1046 dormant warehouse scales, weighing 5,000 lb. to ½ lb	141.42
Furniture, material for office partition, etc	282.88
(See Fig. 30.)	$1,541.12

Account 8813.10—Painting.

This account covers the cost of material and labor of a lot of miscellaneous painting at the warehouse. The steel doors were given one coat of turkey red. The iron lintels were given one coat of lamp black in linseed oil. The counter was stained and oiled.

Account 8813.11—Painting Sash.

This account covers the cost of material and labor used to paint all the warehouse sash. They were given two coats of white lead and linseed oil, cream color.

Laboratory

Account 8820—Excavation.

This covers the excavating for the laboratory walls and basement in red clay with boulders and gravel. It was done with pick and shovel, and wheeled 75 ft. in barrows. Some backfilling for the floors in 3-in. layers is also here included.

Account 8821—Foundation.

This covers the concrete building walls which were machine mixed, in the proportions 8 sand and gravel to 1 cement. The concrete was handled in wagons 250 yd. The walls were 12 in. at top to 18 in. at bottom. One hundred per cent. of the vertical surface was formed.

Account 8821.1—Plain Concrete Floors.

These floors were mixed, 5 sand and gravel to 1 cement, in a machine, transported 1,000 ft. in wagon and laid 4 in. thick with a smooth finish. Sand joints were used. The top finish was ¾ in. thick, 2 parts sand to cement, and was troweled smooth.

Account 8821.2—Reinforced Floors.

These floors were formed, two way reinforced with ½-in. and ⅝-in. rods. In other respects they were the same as 8812.1.

Account 8821.3—Sills and Lintels.

The sills and lintels used at the laboratory were separately moulded reinforced concrete. The concrete was made 3 parts sand and gravel to 1 cement. Three $\frac{5}{8}$-in. rods ran the entire length of both sills and lintels. The lintels were 8 in. by 8 in. by 5 ft. The sills were $4\frac{1}{2}$ in. by 9 in. by 4 ft. 1 in. (See Fig. 34.)

Account 8822—Tile Walls.

This account covers the tile, mortar, scaffolds, mason labor, carpenter labor, and hauling incident to building the tile walls of the laboratory.

Account 8822.2—Carpenter Work.

This account covers the material and carpenter labor incident to the installation of the partitions, ceilings, and roof structure. (See Fig. 31.)

Account 8822.5—Doors, Windows and Frames.

This account covers the cost of the following material and the labor of installing the same, together with the necessary frames.

16 windows 6 ft. 8 in. by 3 ft. $1\frac{1}{8}$ in. by $1\frac{3}{8}$ in. glazed.
5 sash with four, 12 in. by 24 in. lights, glazed.
1 sky light 6 ft. $3\frac{1}{16}$ in. by 6 ft. $9\frac{3}{4}$ in. with 36, 12 in. by 14 in. double strength glass
1 sky light 6 ft. $3\frac{1}{16}$ in. by 4 ft. $6\frac{1}{2}$ in. with 24, 12 in. by 14 in. double strength glass.
1 sky light 4 ft. $1\frac{7}{8}$ in. by 4 ft. $6\frac{1}{2}$ in. with sixteen 12 in. by 14 in. double strength glass.
4 doors 2 ft. 8 in. by 6 ft. 8 in. by $1\frac{3}{4}$ in., glazed.
4 doors 2 ft. 8 in. by 6 ft. 8 in. by $1\frac{1}{2}$ in. glazed.

(See Figs. 32 and 33.)

Account 8824—Wood Fixtures.

The account covers the cost of the laboratory hoods, stacks, benches, cabinets and the like.

Account 8825—Lighting.

This account covers the wiring in the laboratory for lights, hot plates, furnaces, etc.

Account 8826—Plumbing.

This account covers the purchase price of the material below and the labor of installing it.

1 flush closet — 1 distilling apparatus
2 sinks and drains — 1 water tap
Piping, fittings, lead, etc.

Account 8828—Painting.

This covers the cost of the material and labor incident to painting at the laboratory. It is of no value for unit costs.

Account 8829 Plastering.

This covers the cost of plastering material, scaffolds plasterers and carpenter labor used in plastering the inside tile walls of the laboratory. The plastering was contracted at 18 cents a square yard, while the company furnished all material and carpenter labor.

Account 8830 Apparatus.

This account covers the purchase price of the material segregated below, and the labor of setting up the same.

Five 12 in. by 18 in. by 6 in. 110-volt hot plates	$143.08
1 Thompsons analytical balance style 28	91.65
1 distilling apparatus	62.70
1 Hoskins electric furnace	225.53
1 electric drying oven	41.79
Brushes, tubing, funnels, etc	54.23
	$618.98

Account 8831—Oil Centrifuge.

This apparatus was located near the oil tanks in a corrugated iron shed, 4 ft. by 4 ft. by 8 ft. The labor in this account was for the building as well as setting up the centrifuge and delivering the material.

1 Braun oil centrifuge, vertical, direct compound type, 110 volt, alternating	$139.25
Material for shed	18.34
	$157.59

Sample Room

Account 8841 Excavation.

This excavation covered the making of a thin top slice and shaping the ground for a plain concrete floor. The dirt was red clay. It was done with pick and shovel and cast to one side.

Account 8842 Foundation.

This covers the making of a few small concrete walls, machine mixed, 8 sand and gravel to 1 cement. Seventy five per cent. of the vertical surface was formed. The concrete was handled about 450 ft.

Account 8842.1 Concrete Floors.

These floors were of smooth troweled concrete, 5 in. thick, machine mixed, 5 sand and gravel to 1 cement, the top finish 1 in. thick, 2 sand and 1 cement. All of the material was hauled in wagons 500 ft. The concrete was laid in blocks with sand joints.

Account 8843—Walls and Roof Structure.

This account covers the purchase price of the following material and the cost of erection.

Lumber for sides and roof rafters	$148.12
Corrugated iron	47.68
Nails, etc	6.01
	$201.81

(See Fig. 35.)

Account 8843.4—Roof.

This account covers the roof sheathing, composition paper, and the labor incident to installing it.

1,008 b.f., 1 in. by 12 Oregon pine	$31.50
10 squares 3-ply asbestos roofing	45.07
	$76.57

Account 8843.5—Doors and Windows.

This account covers the cost of the following material, and the cost of installing the same:

Two 3 ft. by 7 ft. by $1\frac{3}{8}$ in. doors Twelve 2 ft. $11\frac{1}{4}$ in. by 5 ft. $3\frac{3}{8}$ in. by $1\frac{3}{8}$ in. windows, glazed Frames for doors and windows	$115.24
Miscellaneous	3.61
	$118.85

Account 8844—Oven.

This account covers the making of a drying oven, together with the cost of material and installation. The oven was made in the shops of $\frac{3}{16}$-in. sheet plate, 4 ft. by 2 ft. by 6 ft. high, and lined with $\frac{3}{16}$-in. asbestos mill board. It had suitable shelves of pipe coils.

One oven	$46.77
Steam piping, etc	11.79
	$58.56

Account 8845—Motor Platforms and Fixtures.

This covered the cost of the following material and its installation:

4 bucking boards, 3 ft. diameter by $2\frac{1}{4}$ in. thick	$61.80
21 sheets galvanized iron (No. 18) for pans, etc	53.06
Lumber for one bench top, 3 ft. by 12 ft. for pulverizers, and one bench top 2 ft. by 12 ft. for cutting samples	14.74
	$129.60

Account 8846—Lighting.

This covers the cost of the lighting wiring for seven lights.

Account 8848—Painting.

This covers the cost of material and labor incident to painting the sash of this building, two coats of white lead and linseed oil.

Account 8849—Machinery.

This covers the purchase price of the list of material given below, together with the labor of installing it.

	Factory	Freight	Clifton
Two 2 by 6 roll jaw crushers. (Sturtevant Milling Co.)	$250.00	$51.80	$301.80
4 jaw plates	10.00	0.80	10.80
4 shields	3.00	0.22	3.22
8 toggles	3.00	0.14	3.14
4 toggle seats	4.00	0.11	4.11
2 Jones samplers 10 by 18 in.	40.00	2.25	42.25
4 Braun pulverizers, 9 in. pul			363.48
2 Braun coal grinders, light and loose pulleys, 12 in. diameter			147.62
Moisture scales			20.11
Sieves and miscellaneous			15.47
			$912.00

Account 8849.1 Motor.

This covers the purchase price and cost of installing the following motor.

One 5-h.p. Westinghouse motor	$116.77

Account 8849.2 Shafting, Pulleys and Belting.

This account covers the cost of the material segregated below and the labor of installing it:

One 24 in. by 6 in. by 1 7/8 in. bore wood split pulley Four 26 in. by 6 in by 1 7/8 in. bore wood split pulley Two 22 in. by 2 in. Princeton clutch pulley 26 ft. 1 in. of 1 7/8 in. shafting 4 rigid ring oiling pillow blocks Two 1 7/8 in. safety set collars	$138.13
Leather belting for motor 2 in., 3 in. and 5 in.	32.04
	$170.17

MISCELLANEOUS ACCOUNTS

Account 8901—Derricks and Construction Equipment.

This account is indirect expense, see 8999. The charge covers the cost of all derricks, concrete mixers, carts, wagons, picks, shovels, in fact every tool used during construction.

Account 8902—Sewer System—Cost of Pipe and Laying.

This account covers the cost of the material and labor of laying the same used in the sewer system. The sewer lines aggregated 2,967 ft. of vitrified sewer pipe, ranging from 6 in. to 15 in. in diameter. It was all laid an average depth of 4 ft. below the surface. Concrete manholes for the system are in account 8902.2.

Account 8902.1—Sewer System—Excavation.

This excavation covers the entire trenching or tunneling as was in some cases done for the sewer system. All kinds of soil were run through. The trenches varied from 18 in. to 60 in. wide, and from 2 ft. to 20 ft. in depth.

Account 8902.2—Sewer System—Concrete.

This concrete covered a large number of small jobs including manholes and the like along the sewer lines. In general the mix was 7 sand and gravel to 1 cement.

Account 8903—Permanent Outside Closets.

This covers 3 latrines built of 2 by 4's, 4 by 4's and corrugated iron. In size they were 8 ft. by 19 ft. 6 in. by 8 ft. high. The closet was built of concrete and is cleaned by a periodical flushing of water which is siphoned into a sewer.

Account 8904—Telephone System.

This account is indirect expense, see 8999. It covers the cost of a telephone line from Clifton to the smelter, together with all phones and connections about the plant during construction.

Account 8905—Permanent Outside Lighting.

The material account here is as follows:

Four 110 volt flaming arc lamps	$142.40
Conduit, wire, etc	35.59
	$177.99

The poles here used were old ones previously charged out to construction equipment. The lights were placed at various needed points about the plant and then connected to the nearest 110-volt circuit. Labor costs cover the setting of poles, the connecting of lamps, running a conduit line down each pole to a switch box, and installing the switch box.

Account 8905.1—Temporary Outside Lighting.

This account is indirect expense, see 8999.

Account 8906—Water Pipe Lines—Excavation.

This excavation covers the trenching for all the water lines. It represents all sorts of material excavated from 8 ft. to 15 ft. in depth.

Account 8906.01 Water Pipe Lines Concrete.

This was a small amount of concrete used to anchor the 6-in. line at the foot of the hill, as it comes down from the tank.

Account 8906.02 Water Pipe Lines Cost and Laying.

This account covers the cost of the material and labor of laying all the water lines about the smelter.

There was	2,052 ft. of 6-in. pipe
	1,058 ft. of 4-in. pipe
	200 ft. of 2½-in. pipe
	268 ft. of 2-in. pipe
	115 ft. of 1½-in. pipe
	50 ft. of 1-in. pipe
	4,253 ft.

Total of 4,253 ft. with all necessary fittings, valves, and fire hydrants.

Account 8906.1 Six-Inch Pipe Line from Clifton.

This account covers the cost of the material and labor incident to laying a 6-in. water pipe line, 8,988 ft. long, from Clifton to smelter. It includes excavating, painting, and backfill.

Account 8906.2 Water Supply Tank Excavation.

This covers the making of a 3 ft. slice for a water tank foundation. It involved the use of powder, and was handled with picks, shovels, and wheelbarrows.

Account 8906.4 Water Supply Tank Cost and Erection.

This tank was erected on a hill at an elevation of 200 ft. above the tracks where the material was received. It is 40 ft. in diameter, 26 ft. 9½ in. high, and has a steel cover. Its capacity is 250,000 gallons. The tank steel was erected by contract. The account stands thus:

Road work	$72.80
Hauling	121.31
33.67 tons, tank erected	3,550.00
Freight on tank	235.69
Power for riveting	92.31
Miscellaneous	64.92
	$4,137.03

Account 8907 Watchman.

This account is indirect expense, see 8999. It covers the pay of watchman during the construction period.

Account 8908 Power Distribution.

This account covers the cost of material and labor incident to the following work. Two- and three-inch conduits were run underground

from the power house to the heater house and to the converter building. Along these lines four concrete manholes or pull boxes were installed At the converter building the wire from the conduits run up a steel column and from thence on steel brackets through the reverberatory and boiler building to a point of distribution by poles. From this point the wires go to the roasters, sample mill, crushing plant, and bedding plant. The wire ranged from 1,000,000 c.m. to No. 12 weatherproof.

Account 8908.1—Temporary Oil Tanks.

This account is indirect expense, see 8999. It covers the cost and erection of an oil tank with pipe lines used during the construction period.

Account 8909—Permanent Air Line—Excavation.

This covers the cost of trenching and backfilling for the air lines. The trenches were in every kind of soil, 18 in. to 6 ft. deep and 1 ft. to 3 ft. wide.

Account 8909.1—Permanent Air Line—Laying.

This account covers the cost of material used and the labor of installing the same. The lines together are 2,316 ft. long and composed of the following quantities of different sized pipe.

526 ft., 1-in. pipe	656 ft., 2-in. pipe
36 ft., 1¼-in. pipe	838 ft., 3-in. pipe
80 ft., 1½-in. pipe	180 ft., 4-in. pipe

Account 8910—Transmission of Power to Various Departments.

This is a suspense account which has been charged away.

Account 8911—Watchman House.

This account is indirect expense, see 8999. It covers the cost of a temporary building.

Account 8912—Tool Shed.

This account is indirect expense, see 8999. It covers the cost of a temporary building.

Account 8913—Barn and Corral.

This account is indirect expense, see 8999. It covers the cost of the corral and barn.

Account 8914—Temporary Blacksmith Shop.

This account is indirect expense, see 8999. This is a temporary building used during construction.

Account 8916—Temporary Power Plant.

This account is indirect expense, see 8999. It covers a large compressor, Maune type boiler and temporary building, together with the labor of installation.

Account 8917—Temporary Crushing Plant.
This account is indirect expense, see 8999. It covers the cost and installation of a 10-in. by 20-in. crusher, 65-ft. bucket, elevator, rock and sand bins, shafting, belts, pulleys and motors.

Account 8918—Temporary Water Tanks.
This account is indirect expense, see account 8999. It covers several small tanks erected for use at the temporary camp site, as well as a large general supply, wooden tank.

Account 8919—Temporary Electrical Shop Equipment.
This account is indirect expense, see 8999. It covers a temporary shop equipment.

Account 8920—Wagon Roads.
This account is indirect expense. It covers the building of many roads and trails required during the construction period.

Account 8921—Temporary Pumping Plant.
This account is indirect expense. It covers a timbered shaft, pump and pipe line.

Account 8922—Temporary Pipe Lines.
This account is indirect expense. It covers the cost of all temporary water and air lines laid during the construction period.

Account 8923—Temporary Warehouse.
This account is indirect expense. It covers the cost of the temporary warehouse and equipment.

Account 8924—Temporary Cement Sheds.
This account is indirect expense, see 8999. It covers the cost of corrugated iron sheds for storing cement.

Account 8925—Horses, Harness and Carts.
This is indirect expense, see 8999. This covers the cost of some carts, work harness, and the purchase price of an animal killed during construction.

Account 8926—Temporary Office.
This account is indirect expense, see 8999. This covers the cost of the construction office.

Account 8927—Temporary Lavatories.
This account is indirect expense, see 8999.

Account 8928—Temporary Machine Shop.
This account is indirect expense, see 8999. This covers the cost of temporary machine shop.

Account 8929—Employe's Railroad Transportation.
This account is indirect expense, see 8999. During the construction period 300 to 500 men were employed, over three-fourths of whom lived in and around Clifton. The cost of transporting these men back and forth each day was borne by the construction.

Account 8930—Clearing Land.
This account is indirect expense, see account 8999.

Account 8931—Test Holes.
This account is indirect expense, see 8999.

Account 8933—Furniture and Fixtures.
This account is indirect expense, see 8999. It covers the temporary office fixtures.

Account 8934—Miscellaneous Supplies.
This account is indirect expense, see 8999.

Account 8935—Shop Equipment.
This account is indirect expense, see 8999. It covers material used in various temporary shops.

Account 8936—Overhead Shop Expense.
This account is indirect expense, see 8999. This account covered all labor and supplies used in the shops not directly charged to the work in hand.

Account 8937—Stock Lumber.
This is a suspense account.

Account 8938—Powder Magazine.
This account is indirect expense, see 8999.

Account 8939—Miscellaneous Labor.
This is indirect expense, see 8999.

Account 8941—Temporary Railway Receiving Bins.
This account is indirect expense, see 8999.

Account 8942—Water Supply.
This account is indirect expense, see 8999. It covers the cost of water from Clifton used during construction.

Account 8943—Corral Expense.
This was suspense account distributed at the close of each month, on the basis of the cost per animal-day.

Account 8944—Switching and Freight from Clifton.
This account is indirect expense, see 8999. It was impossible to place these charges to the material freighted, owing to incomplete records.

Account 8945—Office Stationery and Supplies.
This account is indirect expense, see 8999.

Account 8946—Warehouse Operating Expense.
This account is indirect expense, see 8999. It covers the expense of running the warehouse during the construction period.

Account 8927—Timekeeping Expense.
This account is indirect expense, see 8999. It covers the expense of the timekeeping and distribution during the construction period.

Account 8948—Form Lumber.
This is a suspense account. Its money was apportioned to all concrete costs on the basis of board-feet of lumber used on each job.

Account 8949—Cement.
This was a suspense account. It was apportioned to all concrete accounts on the basis of sacks used.

Account 8951—Sand and Gravel.
This is a supense account. Its money was apportioned to the different concrete accounts on the basis of cubic yards of concrete cast.

Account 8952—Employe's Quarters.
This account is indirect expense, see 8999. It represents the cost of a boarding house, bath house, and 42 tent houses, less the rent they paid on during the construction period.

Account 8953—Crushing Plant Operating Expense.
This is a suspense account. Its money was apportioned to the different concrete jobs on the basis of cubic yards of concrete benefiting.

Account 8954—Concrete Power and Repairs.
This is a suspense account, see 8953.

Account 8955—Mortar Sand.
This is a suspense account. It was apportioned to the brick-work on the basis of the amount used by the various jobs.

Account 8955.1—Mortar Lime.
This is a suspense account, see 8953.

Account 8955.2—Mortar Cement.
This is a suspense account, see 8955.

Account 8955.4—Fire Brick Mortar.
This is a suspense account, see 8955.

Account 8955.5—Silica Brick Mortar.
This is a suspense account, see 8955.

Account 8956—Operating Temporary Power House.
This is a suspense account. It was apportioned to the various jobs on the basis of horse power days.

Account 8957—Maintenance of Track in Yards.
This account is indirect expense, see 8999. It represents the upkeep of tracks during construction, and the cost of many temporary construction tracks.

Account 8958—Ditch at Tunnel No. 2.
This account is indirect expense, see 8999. It represents a ditch built by the Arizona & New Mexico Railway, to protect their main line which has been endangered by surface water as a result of the site chosen for the smelter.

Account 8961—Steam Heating System—Excavation.
This covers the making of a long shallow trench and backfilling it. The ground was red clay.

Account 8961.1—Steam Heating System—Cost and Installation.
This covers the cost of laying 260 ft. of 2-in. steam pipe and 236 ft. of $2\frac{1}{2}$-in. steam pipe in a 2-in. lumber box. The pipe was covered with double standard magnesia covering.

Account 8975—Cleaning Up.
This account is an indirect charge, see 8999. It represents cleaning up about the plant after construction.

Account 8976—Rehandling Brick and Tile.
This account is an indirect charge, see 8999. It represents handling tile not directly chargeable to the jobs where the tile was used, but as a result of other considerations.

Account 8998—Direct Charges.
This account is indirect expense, see 8999. It represents direct charges to indirect expense.

Account 8999—Indirect Expense.
This account is a summation of the accounts, as listed under charges to indirect expense. As the total of indirect expense, they represent a percentage of the total cost of the smelter, less the engineering and and indirect expenses, and have been so reported. In the making of any total estimate based on the unit costs derived from this sheet, it is assumed that of the total estimate, 7.53 per cent. will be taken to ascertain the item of indirect expense.

POWER PLANT

Power House

Account 9001—Excavation.

This excavation was a large cut, about 55 ft. by 280 ft. by 10 ft., for the basement of the power house, the machine foundation and the building piers. The material encountered was red clay and boulders on top, with sand and gravel beneath which was saved for concrete material. Powder was used, followed by plowing, picks, shovels, fresnos, and carts. The material was hauled 450 ft. (See Fig. 53.)

Account 9002—Building Foundation Piers.

This concrete was cast in piers which supported the steel columns. The piers were about 3 ft. by 4 ft. by 3 ft. plain concrete, hand mixed, in the proportions of 7 sand and gravel to 1 cement, and transported 150 ft. in wheelbarrows to place. A great deal of difficulty was experienced here in keeping out the sand and gravel which constantly *sluffed* in from the sides. Fifty per cent. of the vertical surface was formed.

Account 9002.1 Building Foundation Walls.

This concrete was cast as a long reinforced wall running around outside and bearing on the columns of the building. It is 12 in. at top, 20 in. at bottom, 11 ft. high, designed as a slab to withstand earth pressure on a 20-ft. span. The concrete was machine mixed in the proportions of 5 sand and gravel to 1 cement, wheeled 150 ft. to place and reinforced with $\frac{7}{8}$- and $\frac{3}{4}$-in. rods variously spaced. Ninety-five per cent. of the vertical surface was formed. (See Fig. 47.)

Account 9002.2—North Tunnel.

This concrete was cast as a box culvert in an open cut. It is about 6 ft. by 7 ft. by 300 ft. long. It was hand mixed in the proportions of 5 sand and gravel to 1 cement, wheeled 100 ft. to place and reinforced with $\frac{1}{4}$ in. and $\frac{1}{2}$-in. rods. Fifty-five per cent. of the vertical surface was formed, as well as the roof of the culvert. (See Fig. 50.)

Account 9002.3 Concrete Drain.

This concrete forms a drain through the middle of the power-house basement. There are two walls, 10 in. thick, 18 in. high, 3 ft. apart, with a 9-in. bottom in the drain laid on grade. The concrete was one-half machine and one-half hand mixed, in the proportions of 7 sand and gravel to 1 cement, wheeled in barrows 150 ft. to place. Ninety per cent. of the vertical surface was formed.

Account 9002.4—Basement Floor Concrete.

This concrete was cast as a floor on grade in the basement of the power house. It was laid in 6-ft. blocks with sand joints. The mixture,

machine made, was 7 parts sand and gravel to 1 cement. The top finish was $\frac{3}{4}$ in. thick and made 2 parts sand to 1 cement. The total thickness of the floor is 4 in. The concrete was transported in barrows on an average of 125 ft.

Account 9002.45—Basement Floor Painting.

This account covers material cost and labor of cleaning floor and applying two coats of Toch Brothers cement filler.

Account 9002.6—Preparing of Concrete for Painting.

This covers the cost of preparing basement concrete walls for painting. The air holes were filled, rough surfaces smoothed, and one coat of cement grout applied.

Account 9002.7—Painting Concrete.

This account covers the cost of the material and labor of applying it to the power house basement walls. One coat of Wadsworth Howland Bay State cement coating was put on. This cost $1.88 a gallon f.o.b. Clifton. The material account is as follows:

150 gallons of paint	$281.40
Brushes	8.42
Turpentine	5.71
Miscellaneous	6.08
	$301.61

Account 9003—Steel Structure.

This account covers all the structural steel including railings and the like used in the power house building. There were 254.29 tons. (See Fig. 54.)

Account 9003.1—Tile Walls.

This account covers the cost of all the tile, mortar material, scaffolds, mason labor, carpenter labor, and hoisting power required to lay up the walls. The walls were 40 ft. high on the average from the ground level. The walls were 8 in. thick, laid directly upon the concrete walls. See account 9002.1. Two mortars were used in laying up the tile, one with lamp black in to give the outside joint a pleasing appearance. The joints were struck. The mortar mixture was 1 cement, 3 sand, and 1 lime. (See Figs. 52 and 54.)

Account 9003.11—Unloading Tile.

This account covers the preparing of the site for unloading, checking quantities and unloading the tile used in the power plant.

Account 9003.12—Wall Coping.

Similar to account 8703.22, which see. The depth of this coping was, however, 18 in. against 12 in. at the warehouse and shops.

Account 9003.2—Doors, Windows and Frames.

This account covers the doors, sash, hardware and frames listed below, together with the labor cost of installing the same. The steel frames were made by the Kansas City Structural Steel Co.

	Factory	Freight	Clifton
105 single sash, 2 ft. 8⅛ in. by 5 ft. 1½ in. by 1⅜ in. glazed with 15 ribbed glass lights, fixed sash	$325.50	.....	.....
1 single sash, 2 ft. 8⅛ in. by 4 ft. ¼ in. by 1⅜ in. glazed with 12 ribbed glass lights, fixed sash	26.00	.....	.....
73 windows, 2 ft. 8⅛ in. by 6 ft. 3 in. by ⅛ in. glazed with 18 ribbed glass lights, double hung	284.70	.....	.....
40 sash, 3 ft. ⅛ in. by 2 ft. 6½ in. by 1⅜ in. glazed with 6 ribbed glass lights, hinged	56.00		
		$93.05	$785.25
Steel frames for all but the 40 6-light sash and 6 door frames, 3 ft. 1 in. by 7 ft. 6 in.	1,815 20	292.77	2,107.97
300 Caldwell sash balances, No. 18	.....	.....	111.95
3,884 ft. b.m. lumber for frames for 40 single sash	.....	.....	91.44
Locks, hinges, nails, etc	.....	.....	223.32
			$3,319.93

(See Fig. 51.)

Account 9003.21 Concrete Sills.

This account covers the material used and the labor expended in making the power house concrete sills. About one-half of the sills were cast in place and the remainder as separately moulded members. They were 8 in. by 10 in. for the windows and 3 in. by 10 in. for the fixed sash at the top of the building. The material was hand mixed, 3 sand to 1 cement, and ⅝-in. rods ran the length of the sills. (See Fig. 51.)

Account 9003.3 Ventilators.

This covers the cost of 6 48-in. Burt ventilators with square base and the labor of installing them on the roof of the power house. They were lifted onto the roof with a locomotive crane.

6 Burt ventilators	$280.17	$152.57	$432.74
Miscellaneous			7.02
			$439.76

Account 9003.4 Main Floor Columns.

This account covers the cost of the material, fabrication, and labor of erecting 57 pipe columns and 11 structural steel columns to support the steel beams of the power house floor. The 57 pipe columns were made of 4-in. pipe, with a cast iron base and capital, and were so placed

hat they might be easily shifted a foot or two along the low flange of he I beams they support, should they interfere with future piping chemes. The structural columns were permanently located. The aterial segregated is as follows:

Caps and bases, cast iron	$227.80
668 ft. of 4-in. pipe	186.40
Structural steel and rivets	136.99
Miscellaneous	75.25
	$626.44

ount 9003.41—Main Floor Slab—Concrete.

his account covers the cost of the Berger multiplex plate laid on the eel I beams of the power-house floor, and covered with concrete rein- rced with ½-in. and ¼-in. rods. The Berger plate was laid upon eel beams and not wired; ¼-in. and ½-in. rods, 1 ft. on concrete, ere laid in the concrete at right angles with the grooves of the plate. he concrete mixture was 7 parts sand and gravel to 1 cement, machine ade. The top finish was proportioned 2 sand to 1 cement. It was id ¾ in. thick, smooth troweled, and marked off in 6-ft. squares. he material account stands thus:

102.1 square, 3-in. Berger plate	$2,101.88
¼-in. and ½-in. reinforced steel	62.06
Concrete materials	1,177.67
	$3,341.61

ee Fig. 55.)

ount 9003.42—Painting under Side Main Floor.

he Berger plate exposed beneath the floor of 9003.41 was cleaned of ust and painted two coats of linseed oil and white lead, cream color. his necessitated low scaffolds. The square yards in which the unit ost is reported are the yard measurements derived from developing he plate. This cost covers the material and the labor.

ount 9003.43—Painting Top Main Floor.

his account covers the labor and material used in painting the upper rface of the power house Berger plate concrete floor. It was given wo coats of Toch Brothers cement filler and one coat Toch Brothers arm gray cement paint, after the floor had been well cleaned and ried out.

ount 9003.5—Berger Multiplex Plate.

his account covers the material and labor used in putting Berger late upon the power-house roof. The eaves of the roof are 41 ft. from he ground and the floor is ¼ pitch. The Berger plate was hoisted

to place by use of a single pulley and hand rope. When laid in position it was wired to the purlins with No. 10 wire. The segregated account stands as follows:

Berger plate	$2,962.25
Wire	20.41
Tools, etc	80.52
	$3,063.18

(See Fig. 56.)

Account 9003.51—Roof Concrete.

This account covers the concrete placed on the roof. It was hoisted to the eaves at various places and transported to position in hand buckets. The concrete was hand mixed, 5 sand and gravel to 1 cement. The top finish was not used, but the concrete was straight-edged to proper level and troweled as smooth as possible. (See Fig. 56.)

Account 9003.52—Roof Tar.

This account covers the cost of the material below, and the labor used in applying it to the roof. A composition of tar, cement and coal oil was made and painted directly upon the concrete roof in an effort to make it waterproof.

11 barrels of tar	$113.74
7 sacks cement	4.95
54 gallons coal oil	6.48
Miscellaneous	2.56
	$127.73

Account 9003.53—Roof Down Spouts and Tile Drain.

This covers the cost of the material used in 10 down spouts and drains, together with the labor employed in erecting them. The down spouts are 4-in. galvanized iron spouts which, after leaving the gutters, pass directly through a hole prepared in the building wall to the inside of the building, and thence to the basement floor. At this point they enter a 4-in. vitrified sewer piper which is laid beneath the floor discharging into the drain down the center of the building. The material account stands as follows:

355 ft. 4-in. vitrified sewer pipe	$117.90
550 ft. 4-in. galvanized iron drain pipe	90.87
Miscellaneous	31.67
	$240.44

Account 9003.54—Roof Painting Underside.

This account covers the cost of the paint material, brushes, scaffolds, etc., together with the labor required to paint the underside of the

power-house roof. High swinging scaffolds from the roof truss purlins were used to work from. They were slow and difficult to move from place to place. The rust was cleaned off and it was given two coats of white lead and linseed oil, cream color.

Account 9003.55—Roof—P and B Roofing.

This account covers cost of material and labor incident to applying a paper roof. Wood strips were imbedded in the concrete around the base of each ventilator, and across the roof at the juncture of the lean-to roof with the main building roof. A cement coating was then applied to the concrete followed by application of hot maltha, with sheets of felt imbedded in the maltha. The felt was so lapped one piece upon another as to give three thicknesses over the entire roof. Another application of hot maltha was swabbed over this ground work, followed by one course of three-ply P and B roofiing paper.

Account 9003.60—Painting Sash.

This account covers the material and labor incident to painting all the power-house sash three coats. Linseed oil and white lead was used.

Account 9003.61—Painting Woodwork.

This account covers the painting of the power-house doors and miscellaneous woodwork.

Account 9004—Crane.

This crane has a capacity of 20 tons. It is operated by hand and spans the power-house floor, a distance of 50 ft. It has a 40-ft. lift and runs on 50-lb. rails. The account covers the material as shown below, and the labor of erecting the crane:

One 20-ton hand traveling crane	$1,278.00
Freight on same	408.00
Miscellaneous	37.27
	$1,723.27

Account 9005—Well Grading.

This covers the cost of grading off a point of conglomerate rock in preparing a site for a well. Large blasts of dynamite were used.

Account 9005.1—Shaft Sinking.

This covers the cost of sinking a shaft in conglomerate at the waters edge upon the site prepared by account 9005. The shaft was 6 ft. by 8 ft. and went to a depth of 45 ft. It was necessary to install and run a No. 7 Cameron pump to handle the water.

Account 9005.2—Timbering.

The timbers used were 8 in. by 8 in., Oregon pine square-shaft sets, making two compartments in the shaft. The shaft was lagged.

Account 9005.31—Aldrich Pump Installation.

The money expended under this account was for unloading two pumps which were not installed.

Account 9006.01—Nordberg Blowers—Foundation.

These two concrete foundations were each about 30 ft. by 15 ft. by 20 ft. The concrete was mixed 6 parts sand and gravel to 1 cement by machine, and transported 50 ft. to place. 100 per cent. of the vertical surface was formed. Each foundation had over thirty bolts set exact with template and piped. The pipes were in short pieces pulled up as the foundation raised and out at the completion. The cost of these pipes and the bolts are in every case given in the concrete cost. (See Fig. 49.)

Account 9006.1—Nordberg Blowers Cost and Installation.

This account covers the cost of the material as listed below, together with the labor of erecting the same. These engines are two Nordberg cross-compound blowing engines, designed to compress 10,000 cu. ft. of free air at an altitude of 3,500 ft. to 12 lb. pressure, while 15 lb. may be carried if desired. The high-pressure steam cylinder is 20 in., the low-pressure 42 in., while the air cylinders are 44 in., all having the common stroke of 42 in. The engines are furnished 160 lb. steam pressure, superheated 75° F. The speed is 71 r.p.m. The labor of grouting, and the labor of testing out and starting up are included here.

2 Nordberg blowing engines, with receivers	$30,967.34
2 No. 34 crane tilt traps	107.78
Grout, etc	1,438.90
	$32,514.02

Account 9006.2—Nordberg Blowers Painting.

This account covers the cost of material and labor of painting the two Nordberg blowing engines. All of the power-house machinery was painted by contract for the sum of $820. This sum covered the labor and all tools, such as brushes, putty knives, light ladders, etc. The paint, oils, colors, dryers, and scaffolds where necessary were furnished by the company. The money covered by the contract and material used was apportioned to the painting account of the different pieces of machinery on the basis of the time spent on each piece of machinery. Every machine was given one coat of paint, one coat of filler, and two coats of olive-green enamel.

Account 9007.01—Turbines—Foundation.

This concrete is identical with 9006.01.

Account 9007.1 Turbines—Cost and Installation.

This account covers the purchase price of three Curtis turbines and material as listed below, together with the labor of erection, grouting, wiring from generator to switchboard, testing and starting up. The turbines are 2,000-k.w. Curtis-type horizontal shaft engines and direct connected to 2,500-k.v.a., 6,600-volt, 60-cycle, 3-phase, 1,900-r.p.m. generators. The approximate size of each unit is 23 ft. 8 in. long by 10 ft. 6 in. wide by 9 ft. 7 in. high, with a net weight of 108,300 lb.

3 turbines	$77,828.10
486 gallons of gargoyle turbine oil	233.04
Grout, electrical material	1,525.35
	$79,586.49

Account 9007.2—Turbines—Painting.

See account 9006.2.

Account 9007.3 Turbines—Air Pipe Making.

(See Fig. 57.) This account covers the making of the air ducts for the three turbines. They were fabricated in the smelter shops of No. 16 steel with $2\frac{1}{2}$ by $2\frac{1}{2}$ by $\frac{1}{4}$ angles. The total length for the three was 103 feet.

Account 9007.4—Turbines—Air Pipe Erection.

This account covers the labor of erecting the air ducts in account 9007.3. The material used was cloth insertion packing, rivets, hangers, anchors, etc.

Account 9007.51—Transformer Trucks and Transfer Table.

This account covers the placing of 325 ft. of 40-lb. rail for installing 15 transformers with trucks, and the cost of those trucks. (See Fig. 58.)

Account 9007.52—Auto Transformers.

This account covers the cost of the 10 transformers oil and wire as listed below, together with placing wiring, trying out and testing the same.

10 oil-cooled auto transformers for raising voltage from 6,600 to 13,200 volts, G.E. Type "H," 60 cycles	$11,801.81
417 k.v.a. Y connected. (3 transformers to a turbine and one spare). Oil and wire	243.10
	$12,044.91

Account 9008.01—Condensers—Foundation.

These were plain foundations machine mixed, in the proportions of 1 cement to 6 sand and gravel. The vertical surfaces were 100 per cent. formed.

Account 9008.1—Condensers—Cost and Installation.

This covers the cost of 3 Alberger surface condensers and the labor of placing and grouting them in position. Each condenser has 7,600 sq. ft. of surface.

3 Condensers	$19,436.04
Grouting, etc.	127.51
	$19,563.55

Account 9008.2—Condensers—Painting.

See account 9006.2

Account 9009—Jet Condenser Hot Well Excavation.

This covers the cost of making small excavations for a few piers in red clay with pick and shovels.

Account 9009.01 Jet Condenser Hot Well Foundation.

This covers a small amount of concrete for piers, hand mixed—6 sand and gravel to 1 cement.

Account 9009.02 Jet Condenser Hot Well Supporting Structure and Tank.

This account covers the cost and erection of 5.76 tons of steel. There was a quadrangular tower 19 ft. 6 in. high, with about 12 ft. base, surmounted with a 10 ft. diameter by 8 ft. 6 in. high steel tank. It was furnished by the Kansas City Structural Steel Co.

Account 9009.03 Jet Condenser Cost and Erection.

This covers the cost of one 28-in. Alberger type "F," barometic jet condenser and erection above the tank of account 9009.02.

Account 9009.12 Jet Condenser Dry Vacuum Pumps.

These air pumps remove the air from the barometic condenser and are located in the power house. The account covers the cost of the material listed below and the labor of erecting the same.

Two 15-h.p. slip ring motors, 440 volts, 3 phase, 60 cycles, 565-r. p. m., with resistance controllers	$739.92
Two 16 by 12 single-stage Alberger dry vacuum pumps	1,888.82
2 circuit breakers	39.88
Grout, cable, conduits, etc.	191.99
	$2,860.01

Account 9009.13—Jet Condenser Dry Vacuum Pump—Painting.
(See account 9006.2.)

Account 9009.21—Circulating Pumps—Foundation.
These are about 15 ft. by 20 ft. by 10 ft. and are similar to 9006.01 in other respects.

Account 9009.22—Circulating Pump—Cost and Erection.
These air pumps furnish the circulating water for the barometic condenser. The cost here includes the price of the material listed below and the labor installing the same.

Two 35-h.p., 440-volt, 60-cycle, 570-r.p.m. motors,.....	$1,687.50
Two 2 Lobe cycloidal jumps, 14 by 12, 17.8 gal. per rev.....	2,341.41
2 oil switches, 660 volt.....	39.89
Miscellaneous.....	66.88
	$3,535.68

Account 9009.23—Circulating Pumps—Painting.
See account 9006.2.

Account 9010.01—Air Compressor—Foundation.
This concrete is 10 ft. by 20 ft. by 15 ft. high. In other respects it is similar to 9006.01.

Account 9010.02—Air Compressor—Erection.
This account covers only the erection at the smelter of the following Ingersoll-Rand two-stage compressor. It was bought from the mines and erected at the smelter power house. The compressor has a steam-driven cross-compound Corliss engine. The steam cylinders are 13 in. and the air cylinders are 22 in. and 13 in. and the common stroke is 36 in.

Account 9010.04—Air Compressor—All Piping Except Steam.
This account covers the cost and erection of all the piping to the Ingersoll-Rand Co. compressor except the steam piping.

Account 9010.05—Air Compressor—Wrecking and Transportation.
This account covers the labor of tearing down this compressor at Morenci, loading it on cars and the freight to the smelter. Such material is charged as was incident to these operations.

Account 9010.06—Air Compressor—Installation of Air Receivers.
This account covers the labor of installing a small air receiver in the power-house basement, for the compressor. No charge was made for the receiver.

Account 9011.01—Two Exciters, Two Air Pumps, Two Circulating Pumps—Foundation.

This is a large foundation about 15 ft. by 20 ft. by 10 ft. In other respects it is the same as account 9006.01.

Account 9011.02—Two Exciters—Cost and Installation.

This account covers the cost of the material listed below and the labor of installing the same. These are the exciters for the turbine generators. They are Ridgway tandem, compound, balanced, slide-valve engines, direct connected to 75-k.w., 125-volt direct-current generators with a speed of 275 r.p.m.

2 exciters	$5,744.96
Cable wire etc	286.28
Miscellaneus	87.02
	$6,118.26

In the labor cost is included wiring and connecting the machines to the switchboard, as well as erecting grouting and trying out.

Account 9011.03—Three Dry Vacuum Pumps—Cost and Installation.

These pumps are for the surface condensers. The account covers their cost, erection, grouting and trying out. They weighed 14,000 lb.

3 dry vacuum pumps 8-in. steam by 20-in. air by 12-in. stroke	$3,136.11
Grout, packing, etc	53.99
	$3,190.10

Account 9011.04—Three Circulating Pumps and Engines—Cost and Installation.

These pumps furnish the circulating water for the surface condensers. This account covers the cost of the material listed below and the labor of erecting and trying out.

3 Lobe, 18 by 20, cycloidal pumps, capacity 49.5 gallons per rev., and Three 27-in. flexible couplings	$4,425.25
Three 11 by 14 Ridgway, simple balanced, slide-valve engines for direct connection to above pumps	4,124.60
Grout, packing, etc	179.43
	$8,729.37

Account 9011.05—Two Exciters—Painting.

See account 9006.2.

Account 9011.06—Three Air Pumps—Painting.

See account 9006.2.

Account 9011.07—Three Circulating Pumps—Painting.

See account 9006.2.

Account 9012.01—Two Motor Generators, One Air Pump, One Circulating Pump—Foundation.

These foundations are 28 ft. by 18 ft. by 11 ft. In other respects they are similar to 9006.01.

Account 9012.02—Two Motor Generators—Cost and Installation.

This account covers the material listed below as well as the labor of unloading, erecting, grouting, wiring to switchboard, and trying out.

Two 150-k.w. synchronous motor-generator sets to supply 250 volt d.c.	$6,450.16
Conduit and wire	317.36
Miscellaneous	62.81
	$6,830.33

Account 9012.05—Two Motor Generators—Painting.

See account 9006.2.

Account 9013—Transfer Table Pit—Concrete.

This is principally a plain concrete slab, 8 in. thick, mixed by hand in the proportions of 6 sand and gravel to 1 cement. About 10 per cent. of the vertical surface was formed. It was chuted to the basement and wheeled in barrows 100 ft. to place.

Account 9013.01—Switchboard—Concrete Compartments.

This is a concrete switchboard, the large dimensions of which are 40 ft. 4 in. long, 4 ft. wide and 13 ft. 2 in. high. Down the center of the board is a 4-in. wall and on each side are 30 pockets made with 2-in. dividing walls. Reinforcing was done with Clinton wire mesh in the 4-in. wall and $\frac{1}{4}$-in. and $\frac{3}{8}$-in. rods were used elsewhere. A great many bolts and insulators were set in the board. The entire board was cast sectionally in place, using 5 parts of sand and gravel to 1 part cement. This cost includes rubbing down the concrete with pummice stone and filling all the air bubble holes and small voids.

Account 9013.02—Switchboard—Cost and Erection.

This account covers the material price of the secondary switchboard slabs. The primary or concrete switchboard construction, however, is in account 9013.01. Here, too, is the material price of the entire equipment for all of the switchboards, both primary and secondary, and the labor of installing the same.

Account 9014—Steam Piping North and South Mains—Excavation.

This covers the excavation for numerous piers done with pick and shovel and cast to one side.

Account 9014.01—Steam Piping North and South Mains—Fo

This concrete composes the piers which support the long s steel steam pipe supports. They were part mixed by machine by hand, in the proportions of 6 sand and gravel to 1 cement 50 per cent. of the vertical surface was formed.

Account 9014.02—Steam Piping North and South Mains—Steel ing Structure.

In these steam-pipe trestle supports 11.8 tons of corrugated 75.01 tons of structural steel were used. (See Fig. 60.)

Account 9014.03—Steam Piping Mains, Hangers and Anchors.

This covers the cost of material and making of all hangers an used for the steam piping between the boilers and the machi power house. The hangers were made of $\frac{3}{4}$-in. rods and $\frac{1}{2}$-in. clamps running around pipe. Anchors were of same mate cated to suit conditions surrounding place used. (See Figs. 60

Account 9014.04—Steam Piping—Cost and Erection.

Under this account all the material listed below is costed, with the labor of its erection. These pipes run from the boil power house in duplicate, making a complete loop about around. The main lines are 10 in. branches from boilers branches to engines of suitable size ranging from 4 in. to 8 in. joints are Van Stone, all valves and fittings are of cast st line is required to stand 180 lb. pressure with 100° F. superhe gaskets used are corrugated bronze. The 10-in. lines are fi six 10-in. Harter expansion joints. (See Figs. 60 and 61.)

Six 10-in. Harter expansion joints	$1,684
One 6-in. cast-iron separator	126
Two 10-in. cast steel vertical separators	843
One 10-in. cast steel horizontal separator	372
Two 6-in. separators and receivers (bot. outlet)	591
One 5-in. cast steel separator and receiver (bot. outlet)	261
Three 4-in. cast steel separators and receivers (bot. outlet)	687
Two 4-in. cast steel separators and receivers (bot. outlet)	476
Corrugated bronze gaskets	251
Ten 8-in. Lagonda valves	1,315
Twelve 10-in. gate valves	2,079
Two 34-in. and one 33-in. Crane tilt traps	143
Best Mfg. Co. pipe and fittings	8,738
Extra pipe and fittings	526
Miscellaneous	522
	$18,622

Account 9014.05—Steam Piping—Covering and Erection.

Part of this work was contract by the people who furnished the material and part was force account. Therefore the material figure given covers a large portion of labor. The total unit cost is the only valuable unit. The steam lines and all fittings were all covered with 85 per cent. magnesia blocks of double standard thickness, wrapped with 6-oz. duck. All of the line was then painted two coats—cream color.

Account 9015—Exhaust Pipe—Cost and Erection.

This covers the cost of the material as listed below and the labor incident to installing it. Some of the piping is cast iron, designed for a vacuum of 14 lb. per square inch. The rest of the piping is lap-welded wrought steel with cast-iron fittings. The installation covers the three 20-in. atmospheric exhausts from the turbines, as well as the exhaust from the blowers, compressors, exciters, engines, and circulating pump engines, to the jet condenser. It covers likewise the connections between the exhaust of the dry vacuum pumps, exciters, engines, surface condenser circulating pumps and the heater house. The pipe ranged in size from 3 in. to 42 in.

Three 42 by 13 Wainwright turbine expansion joints....	$656.70
Three 20-in. atmospheric relief valves.....	804.50
Three 42-in. low-pressure flanged base elbows.....	1,428.61
Three special 8-in. emergency stop valves.....	234.36
One 14-in. automatic atmospheric exhaust relief valve...	123.27
Pipe and fittings.....	4,585.74
Miscellaneous.....	882.48
	$8,715.66

Account 9015.01—Exhaust Pipe—Painting.

All exhaust pipe was given one coat of green silica graphite paint.

Account 9015.05—Exhaust Pipe—Covering and Erection.

The exhaust pipe from the engines in the power house to the heater house were all covered with 85 per cent. magnesia single standard thickness, wrapped in 6-oz. duck. Where the magnesia is exposed to the weather, it is wrapped with No. 28 galvanized iron. This account covers the labor and material incident to the above work. (See Fig. 62.)

Account 9015.10—Air Piping—Cost and Erection.

This is not a valuable cost.

Account 9015.11—Air Pipe—Painting.

This covers the painting of 9015.01. It is of no value.

Account 9015.2—Exhaust Pipe—Foundation.

This covers a number of small concrete piers.

Account 9015.21 Exhaust Pipe Supporting Structure.

This account covers the cost of a number of exhaust pipe hangers, supports and staging used in erecting exhaust pipe. It is not a good cost.

Account 9015.22 Exhaust Pipe Excavation.

Account 9016 Water Pipe Excavation and Backfill.

This account covers the excavation of a trench about 3 ft. deep, through red clay and boulders, for a 16 in. wood stave pipe and the backfill after the laying of the pipe.

Account 9016.01 Water Pipe Cost and Erection.

This account covers the cost of all the material listed below and the labor of its installation. Here is listed all the water piping about the power house the 30 in. cast iron suction pipe line from the cooling tower to the pumps; the 20-in. wooden lines from the pumps to the equalizing tank; the 16-in. wooden line from the jet condenser to the cooling tower, and the 16-in. wooden lines from the equalizing tank to the cooling tower; the 12 in. cast iron lines from the circulating pumps to the jet condenser; the 8-in. line from condenser to condensed water pump house; the 6-in. line from condensed pump house to heater house, etc. (See Fig. 63.)

1998.7, 4-in. machine banded redwood pipe with collars. (Not used at New Smelter)	$397.74
354.6 ft. 20-in. machine banded redwood pipe with collars	365.24
1,104.2 ft. 16-in. machine banded redwood pipe with collars	861.28
22 flanged couplings	590.00
Freight on the above items	632.00
Two 12-in. check valves	97.00
Four 12-in. gate valves	172.00
Three 20-in. gate valves	283.50
Freight on the above items	176.38
Three 20-in. flanged, iron body, bronze mounted, double gate valves	403.49
Five No. 20 gauge copper plates	36.28
Two cast-iron bell and flange fittings, 6 bell bends	81.11
Freight and patterns on above	78.00
220 lb. cloth insertion packing	91.50
Best Mfg. Co. pipe	9,668.92
Pipe, fittings, misc'l material	2,503.44
	$16,437.88

Account 9016.02 Water Pipe Painting.

This covers the painting of the pipe in 9016.01 that was above the ground.

Feed Water Heating Plant

Account 9017—Excavation.

This covers the excavation of the sump and piers, of the feed water heating plant. The material was red clay, with boulders and sand and gravel. The work was done with pick and shovel, cast into carts and hauled 300 ft.

Account 9017.01—Foundation.

This account covers some miscellaneous concrete cast as piers, low reinforced walls, 4 in. to 8 in. thick, and floor slabs. The walls and slab were reinforced with $\frac{3}{8}$-in. rods on 6-in. centers. The concrete was hand mixed in the proportion of 6 sand and gravel to 1 cement and wheeled 50 ft. in barrow to the forms. Seventy-five per cent. of the vertical surface was formed.

Account 9017.015—Reinforced Floors and Stair Treads.

These floors were cast over I-beams in the building structure by using forms which allowed the encasing of the I-beams with concrete. The stairs were structural steel with channel treads. The treads were filled with concrete. The floor and the treads were reinforced with $\frac{1}{4}$-, $\frac{3}{8}$- and $\frac{1}{2}$-in. rods variously used and spaced. The concrete was hand mixed in the proportions of 5 sand and gravel to 1 cement, hosted from the ground 20 ft. to place by means of a small air hoist. (See Fig. 65.)

Account 9017.016—Waterproofing Concrete Tanks.

This consisted of plastering the inside of the concrete tanks at the heater house with the following mixture. One cubic foot cement, 2.5 cu. ft. sand, 1 lb. Medusa waterproof compound mixed with sufficient water. The account covers the labor and material.

Account 9017.02—Steel Structure.

There were 26.63 tons of structural steel in this building.

Account 9017.021—Distribution and Equalizing Tank.

This account covers the material labor of fabrication and erection of this tank. Its dimensions are 13 ft. by 13 ft. by 5 ft. high. It has 8 holes in the bottom averaging 20 in. in diameter. It is located on a concrete floor base 23 ft. off the ground. The weight of the tank is 4,800 in. A material list shows the following. (See Fig. 69.)

17 sheets steel $\frac{1}{4}$ in. by 48 in. by 120 in	$192.96
4 pieces angle iron 3 in. by 3 in. by $\frac{3}{8}$ in. by 20 ft. long	15.15
1,110 b.m. lumber	31.55
Rivets, bolts, nuts, etc	20.89
	$260.58

Account 9017.03 Tile Work.

The walls were started on the concrete floor of the feed water heating plant at an elevation of 26 ft. from the ground. The material was hoisted up by means of a small air hoist. In other respects this account is similar to the tile work elsewhere about the plant.

Account 9017.031 Unloading Tile.

Same as 9003.11.

Account 9017.032 Coping.

Same as account 8703.22.

Account 9017.033 Sills and Lintels.

The concrete sills and lintels for this building were separately moulded as 8821.3, which see. The sills are 3 in. by 8 in. by 3 ft. 9 in. and the lintels 4 in. by 8 in. by 3 ft.

Account 9017.034 Painting Tile Walls.

The tile walls were given one coat of Bay State cement paint after the small holes had been filled and mortar cleaned from the face of the brick.

Account 9017.035 Doors, Windows and Frames.

This account covers the cost of the doors, windows and frames set in place. A segregated material list is as follows. (See Fig. 70.)

3 doors 2 ft. 10 in. by 6 ft. 10 in. by 1 ¾ in. with frames	$20.86
7 windows, 2 ft. 9¾ in. by 5 ft. 9 in. by 1¾ in. with frames	59.88
12 sets Caldwell sash balances, nails, locks, etc	19.24
	$99.98

Account 9017.04 Roofing.

This account covers the material listed below, and the labor of installing the same. The wood sheathing was nailed directly to nailing strips attached to the purlins. The paper was laid over the sheathing. (See Fig. 72.)

Two 166 b.m. 2 by 8 Oregon pine SISIE	$47.60
10 squares asbestos roofing	49.00
Miscellaneous	13.28
	$109.88

Account 9017.045 Ventilators.

This account covers the material used to make two 3 ft. 6 in. diameter ventilators, and the labor of installing one. The ventilators were made of No. 18 gauge galvanized iron. (See Fig. 71.)

Account 9017.05 Treating Tank Concrete.

This is a concrete tank 8 ft. in diameter by 31 ft. 3 in. high, with a conical bottom, the tank is set directly upon the ground. The concrete

was mixed by hand 5 parts sand and gravel to 1 cement, and hoisted to place. The wall of the tank is 5 in. thick suitably reinforced in both directions with $\frac{5}{8}$-in. rods. Two sets of forms were used each 3 ft. 3 in. high. This cost covers all the material and labor of building this tank save the waterproofing in 9017.016. (See Fig. 68.)

Account 9017.06—Receiving Tank No. 1.

This is a concrete tank 6 ft. 6 in. high with 5-in. walls, suitably reinforced in both directions. The tank rests on a concrete floor about 23 ft. from the ground. The concrete details are the same practically as 9017.05. (See Fig. 67.)

Account 9017.07—Receiving Tank No. 2.

This concrete tank is 12 ft. in diameter, 6 ft. high, with 5-in. reinforced wall, supported on reinforced concrete columns 7 ft. high. The column are here included. In other respects the tank account is similar to 9017.06. (See Fig. 66.)

Account 9017.08—Calibrating Tank.

This account covers the material, fabrication, and cost of erecting the following tank:

1 tank 54 in. high, 6 ft. diameter, of $3\frac{3}{16}$-in. plate.

Account 9017.081—Tipping Meter.

This account covers the cost of material as listed below and the fabrication and erection of the same. The tipping meter is set directly over No. 2 receiving tank, in a wood frame attached to the top of the tank. The meter is shown in sketch No. 136.

Lumber, 2 by 4's, 6 by 8's, etc., 876 b.m	$24.47
Galvanized iron No. 10 and No. 12	112.03
2 by 2 by $\frac{1}{4}$ angle iron	3.69
One 6 wheel revolution counter	34.74
Bolts, washers, nails, etc	52:57
	$227.50

Account 9017.09—Heater and Recorder.

This account covers the material listed below and the labor of installing it on the concrete floor of the feed water heating plant, 26 ft. off the ground. The magnesia blocks are the covering for the heater.

	Factory	Freight	Clifton
1 No. 760 Cochrane feed water heater and receiver	$776.75	$204.48	$981.23
1 Wainwright closed feed water heater	775.00	74.64	849.64
One 6-in. Lea recorder and extra float valve	589.00	123.51	712.51
One 6-in. float for receiving tank No. 2			44.60
600 sq. ft. magnesia blocking $1\frac{1}{2}$ in. thick			161.03
300 lb. magnesia cement			22.53
Miscellaneous			42.30
			$2,813.84

Account 9017.1—Sewer Excavation and Backfill.

This was a long trench about 3 ft. deep through red clay and boulders. Both excavation and backfill are here taken care of.

Account 9017.11—Sewer Pipe—Cost and Laying.

This covers the cost of 100 ft. of 24-in. vitrified sewer pipe, cement and miscellaneous material, together with the labor of laying the same.

Account 90171.2—Lighting.

This covers the cost of wiring for lights in the feed water heating plant.

Account 9017.13—Painting.

This covers the cost of painting the underside of the roof, doors, all frames, and window sash. It was done with two coats of white lead and linseed oil, cream color.

Account 9017.14—Wood Walkway and Tank Covers.

This covers the cost of material and its installation as listed below:

Lumber 1,564 ft. b.m.	tank cover 1 by 6 O.P. SISIE rails 2 by 3 and 3 by 3 S4S sills, 2 by 8 ROP 20 in. centers on tank walkways 2 by 8 O.P. SISIE

Account 9017.115—Alterations.

Condensed Water Pump House

Account 9017.20—Excavation.

This was a side hill cut. It includes a backfill made later inside the building foundation for a concrete floor base. The excavation was in red clay, with boulders and sand and gravel. It was done with pick, shovels and wheelbarrows.

Account 9017.21—Foundation.

This concrete was cast as the walls of some square tanks. It was reinforced, mixed by hand in the proportions of 5 sand and gravel to 1 cement. One hundred per cent. of the vertical surface was formed. (See Figs. 73 and 74.)

Account 9017.2—Floor.

This concrete covers the small building walls, large side hill wall, floor slab and tank bottom. Three-eighth inch and three-fourth inch rods were used as reinforcing. One hundred per cent. of the vertical surface was formed. Hand-mixed concrete, 5 sand and gravel to 1 cement, was used.

Account 9017.24—Doors, Windows and Frames.

This account covers the cost of material below with its installation.

2 windows 2 ft. 9⅝ in. by 1⅜ in. glazed, with factory ribbed glass.	$6.51
2 frames for above	9.28
1 door 2 ft. 10 in. by 6 ft. 10 in. by 1⅜ in.	3.02
1 door frame	3.87
	$22.68

Account 9017.242—Tile Work.

This covers the cost of tile, mortar, mason and carpenter labor and hauling. The tile was handled 400 ft.

Account 9017.243—Coping.

Same as 8703.22.

Account 9017.25—Roof.

This account covers the material entering into the roof frame, as well as the sheathing paper and labor of installing the same. The rafters were 2 by 10, with 2 by 8 sheathing tongued and grooved, covered with asbestos paper. (See Fig. 75.)

984 ft. b.m. lumber	$33.49
5 rolls asbestos composition roofing paper	24.50
Nails, etc.	2.84
	$60.83

Account 9017.26—Pumps and Piping.

This account covers the purchase price of the material listed below and the entire labor cost required in installing the same.

2 Goulds No. 2½ single stage, single side suction, centrifugal pumps, arranged for direct connection, capacity of pump 200 gallons per minute, against 80 ft. head Two 10-h.p. induction motors, 1,710 r.p.m., with starters	$530.83
Grouting, pipes, fittings, valves, etc	160.54
	$691.37

Account 9017.27—Lighting.

This covers the lighting of the condensed water pump house.

Power House Miscellaneous Accounts

Account 9018.1—Power and Lighting Transformers.

This account covers the material as listed below, with the labor charge of installing the same, the labor of unloading, erecting, connecting up, drying out, and testing the transformers noted. These are located in the basement of the power house.

2 Burke air break switches	$134.97
Four 200-k.v.a. transformers, 13,200-volt, 440-volt	2,999.80
Two 20-k.v.a. transformers, 440-volt, 220-volt	304.40
One 20-k.v.a. transformer, 440-volt, 110-volt	152.18
Freight on transformers	90.48
Wire, conduit, electrical material	614.04
Transformer oil	282.34
Miscellaneous	136.12
	$4,714.33

Account 9019—Lighting.

This account covers the material and labor of installing the lighting in the power house. The work was all in conduit.

Forty-eight 250-watt tungstens with reflector.
Forty-six 16-c.p. carbon lamps.
610 ft. 1⅛-in. conduit with weatherproof wire No. 12.
1,710 ft.- 1-in. conduit with No. 12 weatherproof wire.
25 ft. brewery cord.

Account 9020—Power House Oiling System.

This covers the cost and labor of installing the power house oiling system. Two 60-gallon feed tanks are so located that the oil is piped to all the engines by gravity. The waste flows to a water separator, thence through filters into a closed tank, from whence by air pressure it is forced up to the feed tanks.

Account 9021—Benches, Bolt Racks, Etc.

Under this account were built a number of benches, a rack for bolts, a telephone booth, wrench board, and a number of miscellaneous carpenter jobs about the power house including the replacing of about 50 broken panes of glass. The material account stands as follows:

Ceiling lumber	$8.23
Common lumber	31.24
Grass	6.39
Miscellaneous	5.94
	$51.80

Account 9022—Instruments and Gauges.

This account covers the purchase price of the following material, and the labor of installing the same:

3 Tagliabue vacuum gauges	$92.58
10 Tagliabue thermometers	92.85
1 vacuum gauge	30.86
1 Bristol pressure gauge	25.30
1 Bristol gauge	22.95
1 Bristol gauge	21.35
1 clock	46.63
Miscellaneous	10.54
	$343.06

Cooling Tower

Account 9050—Excavation.

This excavation entailed the making of a surface cut and two long trenches. The material encountered was red clay filled with caliche. It was done with pick and shovel and handled in carts and wheelbarrows.

Account 9050.01 Backfill.

This backfill was made to bring the ground up to proper level for the cooling tower floor. Fresnos and scrapers were used to transport the dirt which was tamped in 4-in. layers.

Account 9051—Foundations—Sumps and Gutters.

This concrete was cast as a large number of piers about 1 ft. by 1 ft. by 4 ft. as a sump 35 ft. by 10 ft. by 13 ft. with reinforced walls 8 in. thick, and as two gutters 626 ft. long, in cross section about 3 ft. by 3 ft. having 4-in. reinforced concrete walls. The concrete was hand mixed; for the piers 7 sand and gravel to 1 cement; for the futters and sump, 5 sand and gravel to 1 cement. In the sump $\frac{3}{4}$- and $\frac{5}{8}$-in. rods were used and in the gutters $\frac{1}{2}$-in. The vertical surfaces of all the above were 100 per cent. formed. (See Fig. 107.)

Account 9051.02—Floor.

Between the gutters of the cooling tower is a reinforced concrete slab about 28 ft. 6 in. by 600 ft. by 4 in. thick. Clinton wire cloth 86 in. wide with a 4 in. by 4 in. mesh was used. No top finish was used but the concrete was straight edged and troweled. It was mixed by hand, 5 sand and gravel to 1 cement, and wheeled 150 ft. to place, in barrows. (See Fig. 107.)

Account 9051.03—Waterproofing Concrete.

See account 9017.016.

Account 9052—Woodwork.

The tower is built of wood and is 626 ft. long 35 ft. 6 in. wide at the base, by 20 ft. 6 in. high. Sketch No. 76 shows the design in other particulars.

Account 9053—Alterations.

Oil Supply Sump and Pump House

Account 9060—Excavation.

This excavation consisted of two deep cuts through red clay and boulders into sand and gravel. The work was done with plow, slips, picks and shovels.

Account 9060.01—Concrete.

This covers the making of a covered reinforced concrete sump, the general dimensions of which are 5 ft. by 10 ft. by 140 ft. with walls 8 in. thick—top and bottom slab 5½ in. thick, also a pump house about 20 ft. by 20 ft. by 20 ft. high, with walls 10 in. at top and 20 in. at bottom. The walls were reinforced with ¾-in. rods and the sump with ⅝-in. rods properly placed. The concrete was machine mixed in the proportions of 5 sand and gravel to 1 cement, wheeled in barrows an average of 125 ft. About 80 per cent. of the vertical surface was formed. (See Fig. 37.)

Account 9060.02—Pumps.

This account covers the cost of the following material and its erection in the pump house.

Two 5 by 8 Aldrich vertical triplex, single-acting pumps, 37 r.p.m. with metallic packing	$1,597.91
Two 10-h.p. induction motors, squirrel-cage, 3-phase, 60-cycle, 440-volt, 850-r.p.m	287.22
2 auto starters	
2 overload releases calibrated from 6 to 18 ampere per terminal	124.36
Miscellaneous	26.09
	$2,035.58

Account 9060.03—Inlet Piping to Sump.

This covers the cost of the following material and its installation between unloading tracks and the oil sump. (See Fig. 38.)

Six 10-in. wrouvht pipes 18 ft. long	$85.54
Six 10-in. cast-iron cells	38.64
Miscellaneous	2.37
	$126.55

Account 9060.44—Lighting.

This covers the cost of material and the labor of installing four drop lights in the pump house.

Account 9060.05—Roof Steel Work.

This covers the cost of the following material and the labor of installing it. (See Fig. 39).

1,876 lb. 10-in. I-beams
320 lb. 8-in. I-beams

Account 9060.06—Doors, Windows and Frames.

This covers the cost of the following material and the labor of installing it in the pump house. (See Fig. 41.)

4 sash, 3 ft. by 2 ft. 6½ in. by 1⅜ in	$17.79
2 sash, 3 ft. by 4 ft. by 1⅜ in	14.05
2 sash, 2 ft. 6 in. by 4 ft. by 1⅜ in	12.13
Lumber for doors and all frames	12.69
Hardware	8.36

Account 9060.07—Roof.

This covers the cost of the roof material as given below with the labor of placing the same. The "hyrib" was placed upon the steel of 9060.05 wired in place, covered with 2 in. of concrete, 5 sand and gravel to 1 cement, and plastered on top and bottom, with 1 part cement, 3 sand, ½ hydrated lime. Later it was covered with P and B roofing, see 9003.52. (See Fig. 39).

784 ft. No. 24 "hyrib"	$77.41
7 squares P and B roofing	48.39
Concrete plaster material	36.86
	$162.66

Account 9060.075—Ventilators.

This covers the cost of material in the making and placing of two ventilators shown in Fig. 40.

1 ventilator is 18 in. diameter, 40 ft. high made of No. 20 galvanized iron, using 130 ft. ½-in. guy wire.
1 ventilator is 18 in. diameter, 11 ft. high, made of No. 20 gauge galvanized iron.

Two 500,000 Gallon Oil Tanks

Account 9060.10—Wrecking and Transportation.

This account covers the labor and material incident to taking down at Lordsburg, New Mexico, and transporting to Clifton, two 500,000-gal. oil tanks which had been in use there. The labor item is the cost of tearing down and loading these tanks. The material item is the freight on the tanks between Lordsburg and Clifton.

Account 9060.11—Excavation.

This account covers the making of a top slice to prepare the site for the foundation of the two 500,000-gal. oil tanks. It was done with plow, slips, pick and shovel and handled 150 ft.

Account 9060.12—Foundation.

This concrete was cast as two low circular walls, 1 ft. thick and 2 ft. deep, 62 ft. in diameter. It was mixed by machine, 8 parts sand and gravel to 1 cement, reinforced with two ¾-in. rods and hauled to place 150 ft.

Account 9060.13—Erection.

This covers the erection of the two 500,000-gal. tanks, part on force account by the Kansas City Structural Steel Co. and part by the Arizona Copper Co. It likewise covers the cost of giving them one coat of paint, testing them out, and caulking. Here too are the material prices of the ventilators and gauges. The tanks were 60 ft. in diameter and 25 ft. high. (See Fig. 42.)

Account 9060.131—Roof Supports.

This account covers the cost of the material and labor of installing the same, used for supporting the sheathing over the two tanks. This material amounts to 10,000 ft. board measure for the two tanks. (See Figs. 42 and 43.)

Account 9060.132—Sheathing, Lath and Plaster.

Over the roof supports 1-in. sheathing was laid. On this No. 27 painted expanded metal lath was placed and plastered with a mixture of 1 cement to 3 sand, which was waterproofed with hydrated lime. Each tank has a cornice which ventilates by screened openings through its bottom. (See Figs. 42 and 43.)

Account 9060.14—Railroad Grading.

Along each side of the oil sump a large railroad grade was made. This account covers it.

Account 9060.15—Track Laying and Ballasting.

On the grade mentioned in 9060.14 the following track was laid. The account covers the material and labor of laying and ballasting.

802 white oak ties	$852.60
1 No. 9 frog	158.39
Miscellaneous track fastenings	82.00
	$1,092.99

Account 9060.16—Oil Track Bumpers.

This account covers the labor and material incident to making and putting in place two bumpers at the ends of the tracks on each side of the oil sump. The material is divided thus:

Lumber	$8.52
Iron bolts, nuts, etc.	39.40
	$47.92

Account 9060.17—Bridges over Wood Pipe.

This covers four wooden bridges entirely buried in the fill over a number of wooden pipes. They were placed here to avoid the constant breaking of the pipes. The excavation and backfill are here included. (See Fig. 44.)

Lumber	$70.02
Bolts, etc.	17.12
	$87.14

Oil Supply Tanks for Reverberatories and Boilers

Account 9060.20—Excavation.

This covers a deep cut for a retaining wall. It was in sand and gravel and made with pick and shovel. The material was hauled 300 ft.

ccount 9060.21—Foundation.

This covers the concrete in a reinforced wall about 60 ft. long, 8 in. at top, 18 in. at bottom and 16 ft. high; ½-in. and ¾-in. rods were used for reinforcing. The concrete was machine mixed 5 sand and gravel to 1 cement and wheeled 75 ft. in barrows to place. One hundred per cent. of the vertical surface was formed.

ccount 9060.22—Cost and Erection.

This covers the cost of eight 163-bbl. steel oil tanks, with roofs and ventilators, erected on their foundations.

ccount 9060.23—Piping.

This covers the material and labor cost for 785 ft. of piping, varying in size from 1 in. to 6 in. diameter. Here are also included the fittings and valves. The piping connects the tanks with the pumps.

ccount 9060.40—Piping Excavation.

This includes all the trenching and backfilling incident to the oil lines from the 500,000-gal. oil tanks to the small 163-bbl. tanks. The trenches were 2ft. wide and about 3 ft. deep on the average.

ccount 9060.41—Pipe and Laying.

This account covers the cost of the pipe enumerated below and the labor of laying it.

172 ft.	12-in. wrought-iron pipe
270 ft.	16-in. wrought-iron pipe
850 ft.	8-in. wrought-iron pipe
596 ft.	2½ in. wrought-iron pipe
1,888 ft.	total

A 16-in. line runs from oil sump to pump house, also from pump house to storage tanks. The 8-in. line runs from pump house to the 163-bbl. tanks. The 2½-in. line runs from the wilgus oil pumps to each of the reverberatories.

ccount 9060.5—Heating Installation.

This account covers the material noted below and the labor required to install the same. This 2½-in. steam line is tapped off the steam line at the power house, run under ground through conduit and is packed in asbestos fiber. At the other end the pipe connects with a cast-iron oil heater.

1 cast-iron oil heater	$303.82
1 No. 33 Crane tilt trap	35.91
280 ft. 8-in. conduit	547.49
Asbestos	29.00
2½-in. pipe, fittings, etc	151.82
	$1,068.04